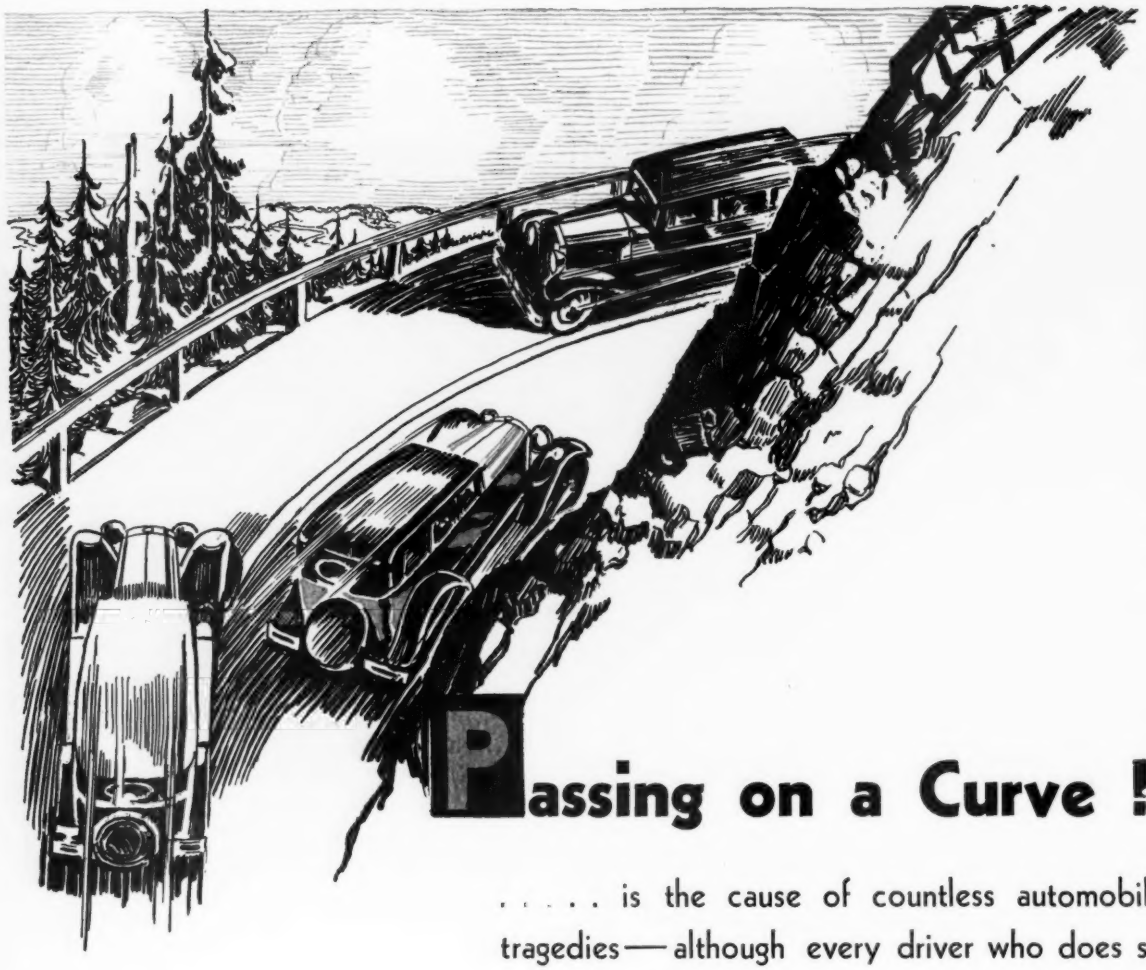
The MINING CONGRESS JOURNAL

LEAD AND ZINC NUMBER

FEATURING THE OPERATIONS OF BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY

NOVEMBER, 1931



Passing on a Curve !

. . . . . is the cause of countless automobile tragedies — although every driver who does so is violating the law.

Similarly, the majority of mine accidents can be traced to some violation of proper procedure.

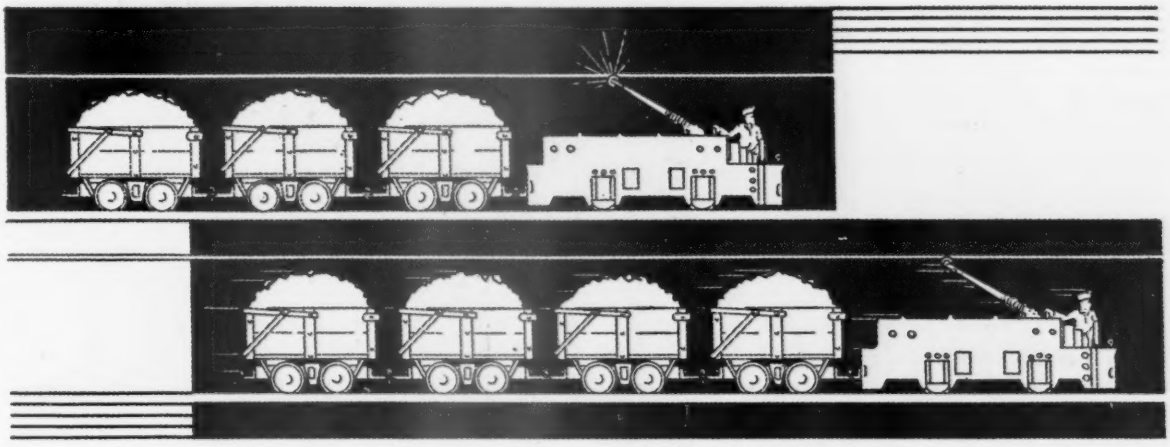
This organization has devoted nearly a hundred years to the development of materials and methods which make blasting inherently safe — and offers definite assistance to mine operators in the establishment of correct methods for the use of explosives with safety fuse.

Do Not "Short Fuse" --Fuse should be cut long enough for the end to extend well out of the mouth of the bore hole when the primer cartridge is in place. All holes should be well tamped.

THE ENSIGN-BICKFORD CO. 1836 SAFETY FUSE 1931 SIMSBURY, CONN.

THE ENSIGN - BICKFORD CO.

SIMSBURY **CONNECTICUT**



INCREASED TRIP SPEEDS 20% ···MOTOR LOADS 33⅓%···

KEEPING DOLLARS *from* WAITING ON DIMES

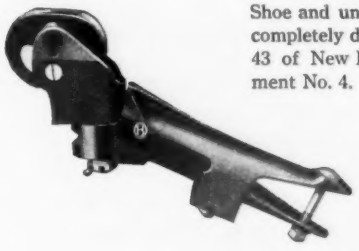
FIVE days service with ten round trips daily was the best record that even the best trolley wheels could establish on an 8800-foot haul at a large Tennessee mine. An O-B Trolley Shoe was given a chance to break this record. It came through in great style. Instead of only the 5 day's service of the wheel, the shoe lasted 49 days. Instead of 10, the round trips made were increased to 12 daily; and loads were increased 33⅓%.

The O-B Trolley Shoe, because of its 2¼ inches of sliding contact, as compared to the point contact of a wheel, eliminates costly arcing and burning of the collector and trolley wire. Both last longer. Likewise heavy amperages are more easily handled with the increased conductor area, enabling speeds and loads to be increased. The shoe clings to the wire, and rides along smoothly; hence there are no delays due to dewirements, nor is the motorman constantly dodging flying trolley poles. In many mines the O-B Shoe is consistently giving from 2 to 5 times more service than the best wheel under identically the same service conditions.

A trial might be the means for showing similar savings on your own cost sheet.

O-B Trolley Shoe

This shoe with its 2¼ inches of sliding contact area is made in either tempered bronze or chrome nickel steel. Shoe and universal harp are completely described on page 43 of New Products Supplement No. 4.



1431M

OHIO BRASS COMPANY

Mansfield, Ohio, U.S.A.

Canadian Ohio Brass Co. Limited Niagara Falls, Ontario, Canada

New York · Philadelphia · Boston · Pittsburgh · Chicago · Cleveland · St. Louis · Atlanta · Dallas · Los Angeles · San Francisco · Seattle

THE MINING CONGRESS JOURNAL

VOLUME 17 NOVEMBER, 1931 No. 11

Contents

EDITORIALS

Plans for Production Control.... 589
Eliminate the Twilight Zone..... 589
The Rising Cost of Government... 590
Where the Burden Falls Hardest.. 590
The North and South Wind..... 590
The Mountain and the Mouse..... 591
Will Rogers on Financial Giants. 591
Rights 591

FEATURE ARTICLES

The Lead Situation—By Clinton H. Crane..... 592
Outlook for Zinc—By A. P. Cobb..... 594
THE BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY—
Foreword—By Stanly A. Easton..... 598
The Bunker Hill & Sullivan Mining and Concentrating Company—By J. W. Gwinn 600
Mining Methods at the Bunker Hill—By J. W. Gwinn and U. E. Brown..... 603
Milling Practice at the Bunker Hill & Sullivan—By J. W. Gwinn and R. S. Handy..... 609
The Bunker Hill Smelter—By H. F. Beasley, P. C. Fedderson, J. B. Schuettenhelm, and J. W. Johnson..... 618
Electrolytic Zinc Plant of the Sullivan Mining Company—By W. G. Woolf and R. M. Miller..... 624
The Northwest Lead Company—By J. W. Gwinn..... 628
Industrial Welfare—By J. W. Gwinn..... 630
Workmen's Compensation—By H. R. McBride 632
Discipline in Relation to Accidents—By F. B. Dunbar..... 635
Automatic Blocks for Inclines and Double Track Slopes—By S. H. Ash..... 637
Modern Mining with Scrapers in High Coal—By G. B. Southward. 638
Tri-State Excellent Convention Host.....641

DEPARTMENTS

PRACTICAL OPERATING MEN'S DEPARTMENT—COAL 635
REPORTS ON THE MECHANIZATION SURVEY 638
NEWS OF THE MINING FIELD..... 643
WITH THE MANUFACTUURERS..... 649

Practical Operating Men's Department

METALS

[Due to the cooperation of Mr. Guy N. Bjorge, Associate Editor, in the preparation of the articles on the operations of the Bunker Hill & Sullivan Mining and Concentrating Company which appear in this issue, the Metals Section of the Practical Operating Men's Department is omitted.]

COAL

Discipline in Relation to Accidents

Automatic Blocks for Inclines and Double Track Slopes

Published Every Month by The American Mining Congress, Washington, D. C.

Edited under the supervision of James F. Callbreath, Secretary of The American Mining Congress

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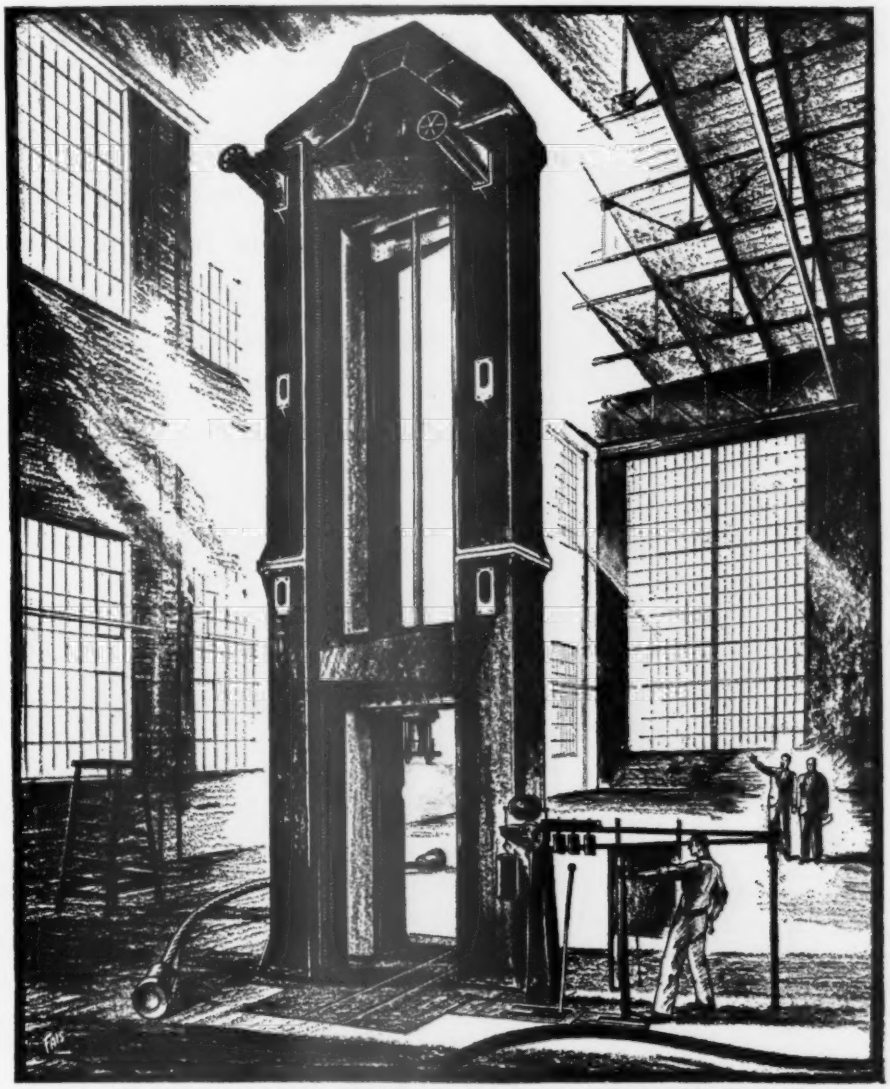
Copyright 1931 by The American Mining Congress, Munsey Bldg., Washington, D. C.
Entered as Second Class Mail Matter January 30, 1915, at the Post Office at Washington, D. C.
Published 13 times annually—the 1st of each month and the 15th of September
YEARLY SUBSCRIPTION, UNITED STATES AND CANADA, $3.00
FOREIGN, $4.00; SINGLE COPIES, $0.50



No. 13 of a series of advertisements on "How Superlative Quality is Built into Roebling Wire Rope"

A *Tower of Torture* for Wire Rope

A 3¼ inch rope is "on the rack". A lever is thrown. The massive screw columns slowly turn. The rope draws taut... now you begin to see its mettle. 500,000 lbs. tension! 1,000,000... the wires begin to snap! Finally... an ear-splitting report... and the broken strands lash back from the break.

So goes one of Roebling's regular routine specification tests on this giant Riehle, built originally to test the huge cables for the George Washington Bridge. It is one of the largest precision testing machines in the world, 2,500,000 lbs. in capacity, 43 feet high, 138 tons in weight. It tests by compression as well as tension... can crush a 15-foot cast iron column, 15" in diameter, with 1¼" walls! This formidable machine marks one extreme to which Roebling goes in testing wire and wire rope. At the other extreme are midget machines to test wire under a few ounces of tension. And in between are machines of every conceivable type and size. To make certain that in Roebling Wire Rope there will be a maximum of strength, stamina and safety, no stone has been left unturned.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N.J.

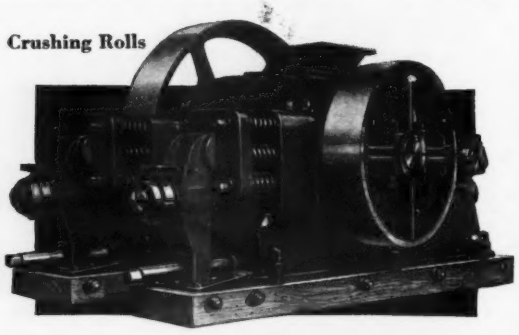
Branches in Principal Cities *Export Dept.: New York*

WIRE · WELDING WIRE · FLAT WIRE · COPPER AND INSULATED WIRES AND CABLES · WIRE CLOTH AND WIRE NETTING

ROEBLING "BLUE CENTER" STEEL **WIRE ROPE**

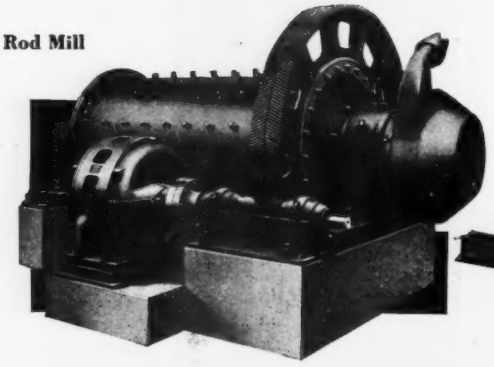
Lead & Zinc Milling....

Crushing Rolls

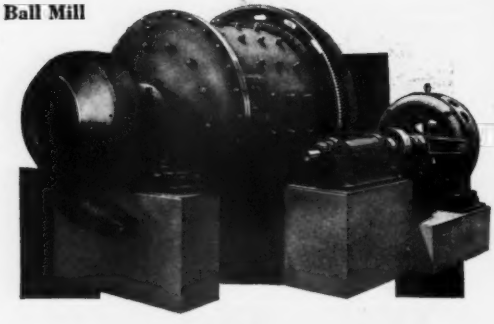


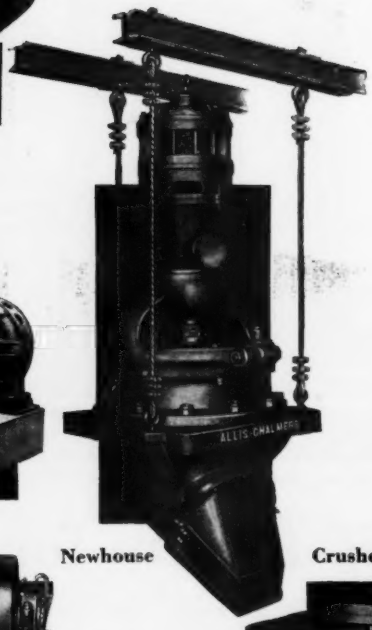
For more than 75 years Allis-Chalmers has been closely connected with the lead and zinc industries, building machinery for practically every part of the plant; supplying not only crushing, screening, concentrating and smelting machinery, but also much of the power and electrical equipment.

Rod Mill



Ball Mill

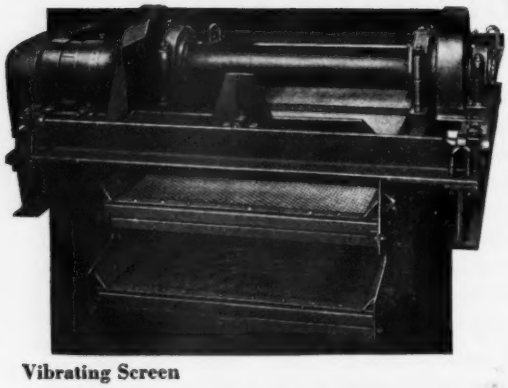




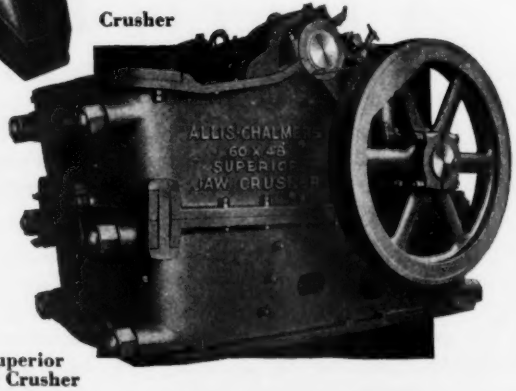
Newhouse Crusher

Products for Lead and Zinc Mines

- Primary and Secondary Crushers
- Ball and Rod Mills
- Crushing Rolls
- Screens
- Jigs
- Concentrating Equipment
- Flotation Plants
- Smelting Equipment
- Electric Power Generating and Driving Equipment
- Motors
- Texrope Drives
- Pumps
- Electric Hoists



Vibrating Screen



Superior Jaw Crusher

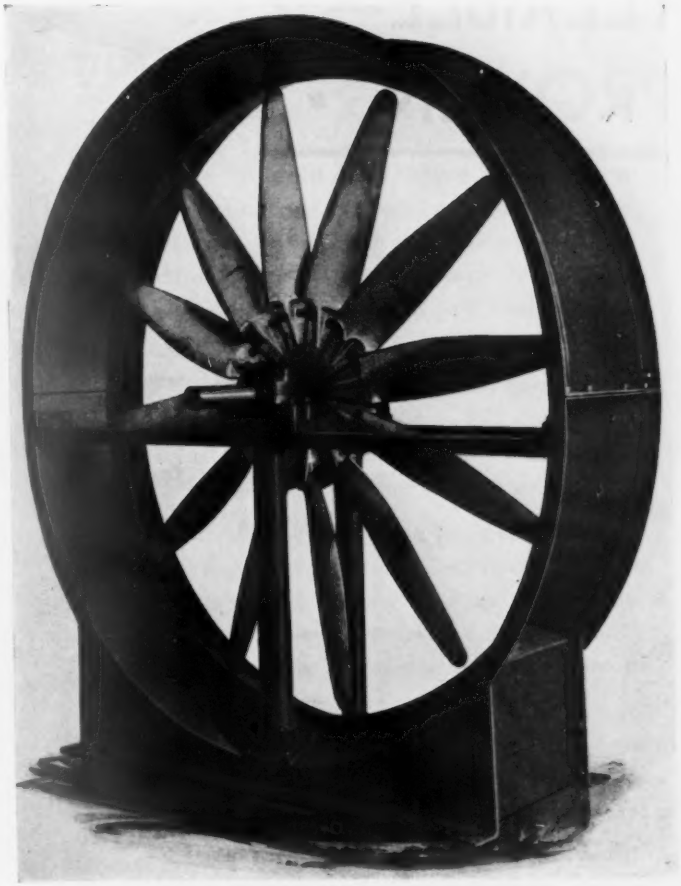
ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

NOW!

A New Type of Mine Fan

Radically Different



The Jeffrey AEROVANE

(PATENTS PENDING)

Higher Efficiency—Less Power

This recent development in mine fans—the Jeffrey Aerovane—has approximately twice the efficiency of the present disc or propeller fan when operating over a wide range of duties.

The Jeffrey Aerovane Fan will replace any disc or propeller type of fan at a power saving that will quickly pay for itself. It will also replace—with large power saving—many centrifugal fans where large volumes with high pressures are not required.

The Jeffrey Aerovane is the only disc or propeller fan that will maintain an efficiency of 70% and above when working between 45% and 75% of its maximum volume.

If you are interested in efficient and economical ventilation at an unusually small investment send for our new Jeffrey Aerovane Bulletin No. 537-B.

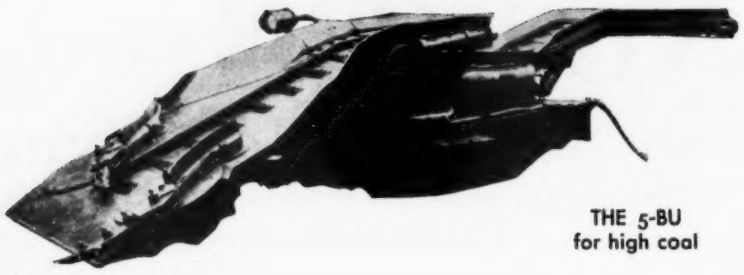
Write for it today.

The Jeffrey Manufacturing Company
958-99 North Fourth St., Columbus, Ohio

BRANCH OFFICES: New York Philadelphia Pittsburgh Scranton, Pa. Huntington, W. Va. Chicago Denver Salt Lake City Birmingham
SALES AND SERVICE STATIONS: Pittsburgh, 600 Second Avenue Scranton, 122 Adams Avenue Terre Haute, Ind., 319 Cherry Street
Price, Utah, 52 North Second West Street Birmingham, Ala., 1911 Ave. A. Winchester, Ky., 122 North Main Street
Salt Lake City, 153 West Second South Street Fort Smith, Ark., 217 South Fifth Street
Jeffrey Manufacturing Co., Ltd., of Canada. *Head Office and Works*, Montreal; *Branch Office*, Toronto; *Service Station*, 210 Ninth Ave., W. Calgary

JEFFREY COAL MINE EQUIPMENT

COMPLETE, EFFICIENT, FLEXIBLE— PROVEN!



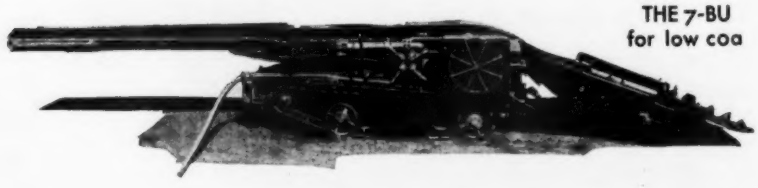
THE 5-BU
for high coal

COMPLETE. Joy Loaders do the complete loading job. They dig into the loosened coal; they keep a continuous stream of coal moving at two tons or more per minute; their flexible conveyors carry the coal over a wide arc, and discharge directly into mine cars. One man controls all operations.

EFFICIENT. Years of service with mounting performance records—Joy Loaders have consistently loaded the majority of all mechanically mined coal—prove the good design and stamina of these machines.

FLEXIBLE. Widely differing mining operations are successfully using Joy Loaders to reduce coal mining costs.

PROVEN. The long service of Joy Loaders in the coal field, their maintained record of performance and their use in all coal fields of the country prove their ability for their jobs.



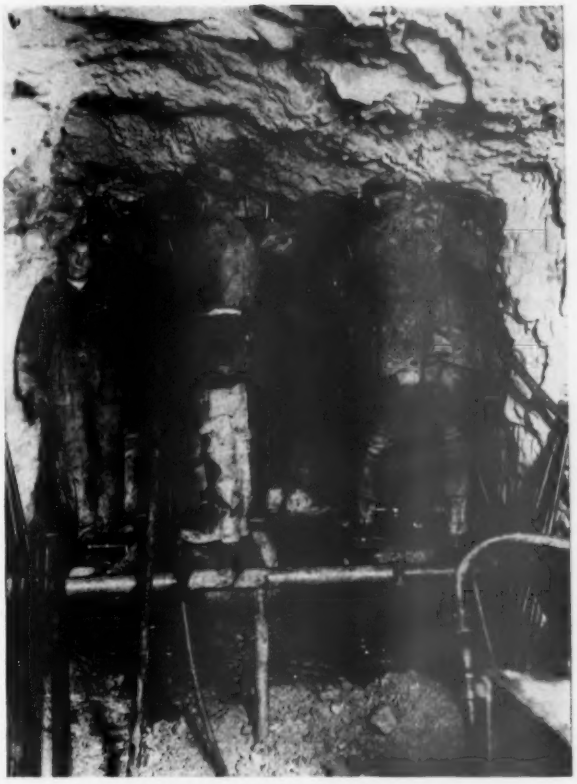
THE 7-BU
for low coa

JOY LOADERS

Let us quote you figures of operations similar to yours. Or, further, let us study your conditions and make estimates of Joy loading performance at your mine—no obligation to you. Any information you desire about the loaders will be gladly furnished upon request.

JOY MANUFACTURING COMPANY
Franklin, Penna.

Shooting
with du Pont GELATIN
in the famous Bunker Hill Mine



(Above) Miners drilling in the Hooper Tunnel of the Crescent Mine.
(Below) Entrance to the Kellogg Tunnel—the main tunnel of the Bunker Hill Mine.

THE BUNKER HILL MINE is the largest producer of lead-silver ore in the State of Idaho, and is one of the few companies in the United States that mine, mill-smelt, refine, manufacture and sell lead ore and lead products.

Mine operations are conducted through the 10,000-foot Kellogg Tunnel . . . the main tunnel of the mine. Production is about 1,400 tons of lead-silver ore per day.

The explosive used exclusively in the operation is du Pont Special Gelatin 35%. This explosive was chosen because of its plasticity — its waterproofness — its uniformity —and because it produces a minimum of harmful fumes.

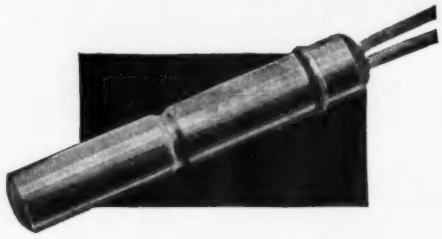
Du Pont Explosives were also used by the Bunker Hill & Sullivan Company in building the Hooper Tunnel in their Crescent Mine. This tunnel is 5,000 feet long and was driven through rock known as Wallace Quartzite, which is of medium hardness, with interposed harder ribs. Du Pont Special Gelatin 60% did the work efficiently and thoroughly.

For specific information relating to selection and use of du Pont explosives, address

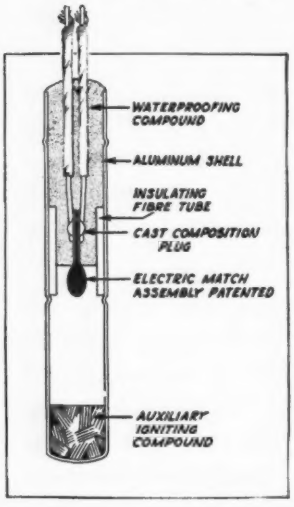
DU PONT
REG. U.S. PAT. OFF.

E. I. DU PONT DE NEMOURS & COMPANY, INC.
Explosives Department . . . Wilmington, Delaware

ATLAS All-Metal, Moisture-proof Electric SQUIB



A *POSITIVE* Electric Squib is one which cannot be ignited by friction in the act of tamping; one which is so assembled that moisture cannot desensitize the igniting compound either while the Squib is in storage or when in actual application; and one which will produce a flame of sufficient intensity to ignite either Granular Black Blasting or Pellet Powder under all normal conditions of application . . . . . *The ATLAS ELECTRIC SQUIB more nearly fulfills these conditions than any Electric Squib ever offered.*



Inasmuch as the tube of the ATLAS ELECTRIC SQUIB is solid—without vent holes—the water-and moisture-proof plug seals the open end and makes moisture-proof the entire assembly. Moisture and grit, therefore, cannot come in contact with the igniting compound of the match head to either desensitize it through moisture absorption or fire it through abrasion with grit.

Other features of the assembly as shown by the accompanying sectional view are as follows:

The Cast Composition Plug seals and centers the match head assembly; and, together with the fibre tube, effectively insulates it from the shell;

The MATCH HEAD holds the bridge wire embedded within it and prevents this delicate wire from being broken by any jars to which the Electric Squib might be subjected.

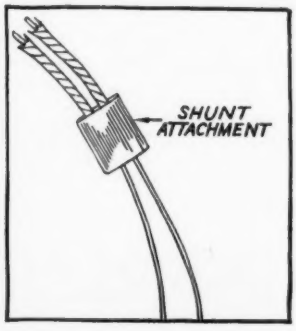
The Atlas Electric Squib is provided with the same Match Head used in the manufacture of Atlas Electric Blasting Caps.

ATLAS Shunt Attachment

The Atlas Shunt Attachment is a well-worth while safety device that can be supplied at no additional cost with all Atlas Electric Blasting Caps and Electric Squibs.

The danger of the loose contact ends of Electric Squibs coming in contact with electric currents in coal mines is ever present because of the extensive use of electrically driven machinery in the mining of coal. Lives have been lost and property has been seriously damaged by the accidental firing of Electric Squibs in this manner. It is well, therefore, that manufacturers have taken steps to eliminate this danger and the Shunt Attachment, designed and patented by the ATLAS Powder Company, provides the simplest and most effective protection.

The Shunt Attachment short circuits the bare ends of the leg wires and prevents any electric current that might be collected by them from reaching the Electric Match within the Squib.



The Shunt Attachment combined with the insulation placed within the shell, completely protects the Electric Squib from accidental firing by stray currents.

ATLAS POWDER COMPANY, WILMINGTON, DELAWARE

Branch Offices:

Allentown, Pa.; Boston, Mass.; Houghton, Mich.; Joplin, Mo.; Kansas City, Mo.; Knoxville, Tenn.; Memphis, Tenn.; New Orleans, La.; New York, N. Y.; Norristown, Pa.; Philadelphia, Pa.; Pittsburg, Kansas; Pittsburgh, Pa.; Pottsville, Pa.; St. Louis, Mo.; Wilkes-Barre, Pa.

ATLAS EXPLOSIVES

Anaconda Copper Bus Bars on the 8000-ampere, 500-volt D.C. circuit to the electrolytic plant of the Bunker Hill and Sullivan Mining and Concentrating Co.

COPPER BUS BARS

serve Bunker Hill and Sullivan

Bunker Hill and Sullivan engineers selected Anaconda Copper Bus Bars for the same reasons that have dictated the use of this product in so many installations throughout industry. The advantages of Copper for bus systems are well known:

The high electrical conductivity of Copper permits smaller and more compact bus installations.

The heat dissipation of Copper, and the metal's high melting point, minimize the danger of arc damage.

The high strength of drawn Copper busses enables them to withstand extreme mechanical stresses set up by short circuits.

Allowance for expansion is less expensive in the case of Copper busses because of this metal's relatively low coefficient.

Anaconda Copper Bus Bars have a guaranteed conductivity of 99% at 20 deg. C., in terms of I. A. C. S. Cold drawn through dies to assure accurate sizing and flat contact surfaces, these bars facilitate assembly and provide for efficient connections. Temper is controlled to meet standard specifications.

The American Brass Co. maintains a Technical Department to assist engineers in adapting Copper, Brass and Bronze to their individual requirements. You are invited to make use of this service.

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Conn.
Canadian Mill: ANACONDA AMERICAN BRASS LTD.
New Toronto, Ont.

ANACONDA COPPER & BRASS

GOLD AND SILVER

"There is grave difference of opinion between those who believe the world's gold supply is sufficient for all purposes and those who believe that the credit money which world commerce has called into being has reached a danger point. . . ."

—The Mining Congress Journal

"At no other time in history has the status of silver occupied so important a position in world-wide discussions as at the present time. . . ."

—The Mining Congress Journal

These two pre-eminent monetary metals will be featured in the December issue of THE MINING CONGRESS JOURNAL. Their past, their present, and their future will be thoroughly discussed, while a review of leading properties in each classification will afford a most interesting insight into their handling of practical operating problems.

Also regular monthly JOURNAL features

DECEMBER *The* MINING CONGRESS JOURNAL **1931**

Progress *in* Mining

The First White Man to Mine Lead in America

When the Sauk and Fox Indians in 1788 gave permission to Julien Dubuque, an Indian trader, to work the Illinois lead mines which they had operated for centuries, Dubuque gained historical significance as the first white man to mine lead in America.

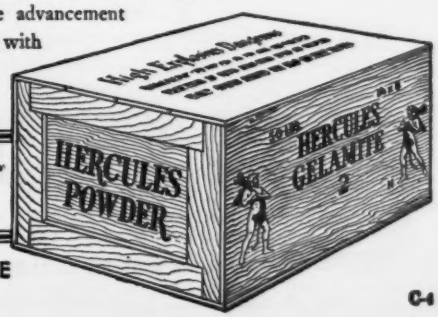
AMERICA'S mines in 1928 produced 627,000 tons of lead ore, valued at $72,000,000—a development which would have been impossible without modern explosives, scientifically used.

In the country's pioneer days, dynamite was unknown. About 1860, came the first crude dynamites, which, though haphazardly used, sufficed until keener competition necessitated lower mining costs. Then arose the demand for better explosives and better ways of using them—*the demand for explosives research.*

For example, when it was apparent that large scale operations were necessary for economical production, explosives research improved the gelatins so that their fumes were satisfactory for underground use.

Spurred by the desire for greater value in explosives of the gelatin type, Hercules research brought forth the Gelamites which are far more economical than the gelatins and can replace gelatin satisfactorily under most conditions. With greater explosives values like this have come better methods of drilling and placing charges with the result that mining costs today are being lowered to a point undreamed of a few years ago.

Constant research for better explosives values; insistence on high quality; accurate control in manufacture; exhaustive field tests of new explosives; and advisory service to assist in determining the best methods of application—these are features of Hercules explosives and service that assure full, honest value today and portend future advancement in keeping with mining progress.



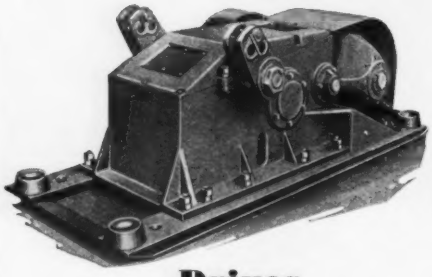
HERCULES POWDER COMPANY
INCORPORATED

934 KING STREET WILMINGTON, DELAWARE

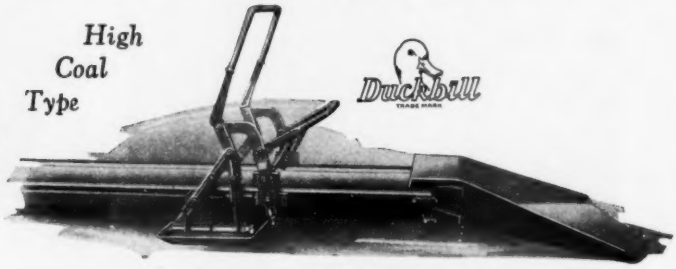
C-4

There's a Goodman Loader for Your Loading Condition

Complete Shaker Conveyor Equipment



High Coal Type

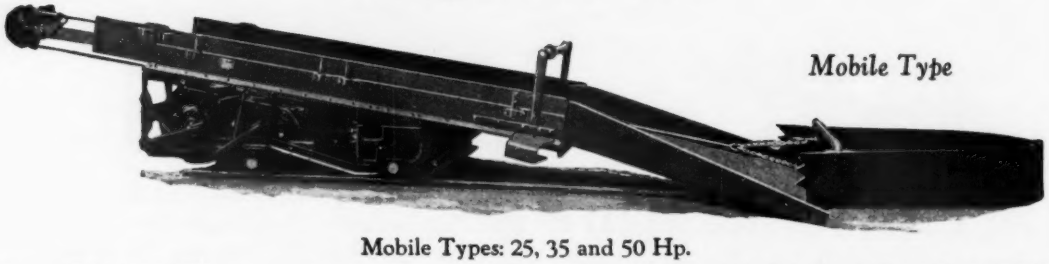


Drives
Two Sizes: 10-15 Hp. and 20-30 Hp.

Duckbills
High Coal and Low Coal Types

also—Troughing—Room Equipment—MacHatson Trough Fastener

Scraper Loader



Mobile Type

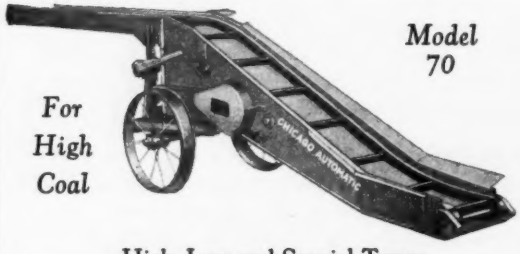
Mobile Types: 25, 35 and 50 Hp.

also—Hoists: Two or three drums: 5, 7½, 10, 15, 20, 25, 35, 50, 75 and 125 Hp.

Pit Car Loader

Model 70

For High Coal



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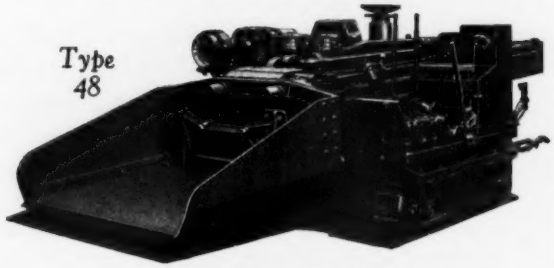

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The
MINING CONGRESS JOURNAL

**A Monthly Magazine—The Spokesman For The Mining Industry—
Published By The American Mining Congress**

VOLUME 17 NOVEMBER, 1931 No. 11

EDITORIALS

Plans for Production Control

WITH increasing momentum the natural resource industries are reaching some point of mutual agreement in respect to a plan that will permit the stabilization of their industries. Many conferences have been held, among the most important of which was the two-day meeting recently conducted under the auspices of New York University. The relation of law and business, as applied to oil, coal, copper, lumber, textiles, radio, aeronautics and labor, was thoroughly discussed. The general opinion seemed to be that business today is hampered, not by legal conceptions of the principles of the Sherman Anti-Trust Law but by a fear of criminal prosecution under its provisions and the possibility that the Supreme Court, in one of its divided opinions, may decide the wrong way. The general sentiment of the meeting was not antagonistic to the Sherman Law, but it strongly favored the development of some means by which business may proceed along lines predicated upon the soundest legal advice obtainable.

The Sherman Anti-Trust Law was enacted 40 years ago, for the purpose of preventing monopoly and curbing restraints of trade. During this period, more litigation has engrossed the attention of the courts with reference to that law than any other one subject. Any law giving rise to so much litigation necessarily develops much opposition, which, of course, is divided into various camps. We, therefore, have a group fully convinced upon the wisdom of the repeal of the law and all of its supporting statutes; another group believes that its administrative features should be changed so as to permit business to do those things which it and its lawyers believe to be entirely legal. One speaker at the New York conference urged that the administration of the law be so circumscribed that it "does not become an instrument of intimidation."

New York University is to be congratulated for having staged so complete a discussion of this subject. Certainly whatever the outcome of all this discussion, industry should be relieved of the threat of criminal prosecution and possible conviction for acts which in themselves serve the highest public interest.

Eliminate the Twilight Zone

THE facts developed and the arguments presented at the law and business conference of New York University are in close accord with the efforts which The American Mining Congress has been carrying on for many years. This organization for a number of years has actively urged the uniting of the natural resource industries upon some plan whereby the twilight zone might be removed and all might act in accord to develop sound, stabilized business. During the year 1912, at the request of a meeting of the leaders in the Illinois-Indiana coal fields, The American Mining Congress prepared a bill proposing the creation of an "Interstate Trade Commission." Its duty was to pass upon trade agreements and operating practices. This Commission was authorized to determine, tentatively, whether any proposed plan created unlawful restraint, and provided that in case of approval by the Commission acts done thereunder would be immune from punishment in the period during which this approval should remain in force. No restriction was placed upon the action of the Department of Justice in bringing such agreement before the court, or upon the right of the Commission to withdraw its approval. This bill did not receive the support of the eastern coal producers, and while filed with the committee, was not introduced in Congress.

The consensus of the New York meeting was that as now constituted the Sherman Law is a medium of intimidation and creates the twilight zone, which honest men are unwilling to enter but into which rogues enter with impunity.

During all of these years The American Mining Congress has advocated such relief as would enable business to control itself without restriction or control by the Government. It believes that a strong factor in the present business depression is the enormous waste in industry made necessary by governmental restrictions growing out of the Sherman Law. The American Mining Congress casts its vote and becomes identified with that group which advocates not the abolition or amendment of the Sherman Law but that the administration of its provisions may be made so clear that there can be no doubt in the minds of business as to its meaning.

The Rising Cost of Government

THE necessity for a reconciliation of our national income and our national budget is at once apparent, even to those least familiar with financial matters or thoroughly sold on the paternal theory in government. The national predicament is one with which most industries are confronted. But the problem of extrication is by no means as simple with government as with industry. Steadily we have fostered the falacious notion that the "Government should do it" and made our notion effective through a vast amount of legislation carrying amazing appropriations, until we have increased the cost of our Federal Government five times in 15 years. In 1915, the cost of administering Federal affairs was $730,586,802; in 1930, the cost had increased to $3,994,152,487. It costs the people of the United States approximately $33 per capita to maintain those agencies created by the people, ostensibly for their service.

Industry generally is seriously concerned with the attitude Congress will take toward the deficit in national expenditures. Will Congress favor a decrease of the budget within our means of support, or will it favor increase in taxes to meet probably not only this deficit, but increased expenditures? There are many bills awaiting attention by Congress that would vastly increase expenditures. They will become laws unless those citizens responsible for the men who compose our national legislature shall make their wishes positively known.

Mining is vitally concerned in this matter. Any increase in taxes for this industry would be but another handicap to the return to prosperity. The tax already paid by the mines is a sizeable proportion of our total tax revenue. It is to be hoped that no further burden will be placed upon the industry.

Where the Burden Falls Hardest

THE recent decision of the Interstate Commerce Commission of the application of the rail carriers for a 15 percent blanket increase in freight rates denied a general increase but it granted an increase in the rates upon the products of the mines. The Commission apparently undertook to relieve the railroads and at the same time conform to the requirements upon which the Hoke Smith bill was based, namely some change which would mean some relief to the agricultural industry.

The American Mining Congress has urged for many years that freight rates upon raw materials should have the most favorable treatment in the transportation rates. These raw materials being only moved from their source of origin are transported again and again in the different forms in which they are fabricated. Iron ore transformed into pig iron and shipped from the furnace to steel plants; there it is transformed into steel and again shipped to the manufacturing plants at which it is fabricated into machinery and again shipped to those manufacturing plants using the machinery. The same may be said of practically every other mineral product that unless the first shipment is made there can be no second shipment.

In view of the fact that the mining industry furnishes more than 60 percent of the tonnage shipped by the railroads of the United States it would seem that it is entitled to the best consideration on other grounds than those cited, and that mining industry will accept with anything but approval the decision placing an increased burden upon it of $125,000,000 annually.

While the 15 percent case apparently bore no relation to the Hoke Smith bill, it seems that the principles of that bill enacted by Congress received special consideration even though that particular issue is under consideration in case Docket No. 17,000, on which hearings have been in progress for some years.

It is unfortunate as well as unfair that the mining industry should be selected to carry this extra burden at a time when it is even more depressed than agriculture. Overproduction in the agricultural industry has a remedy in diversified farming, in which the average farmer can live from the product of his own farm. The products of the mine can be sold only in the open market and are not available in any other way to those engaged in this industry.

The burden of overproduction has greater excuses in the mining world than in agriculture because of the necessity of keeping the plants in operation, to prevent the rusting of machinery, the destruction of mine workings through the accumulation of gas and of being filled up with water. The mining industry must go ahead or suffer the complete annihilation of its capital. The farmer can hang on and raise from his farm the necessities of his table.

Any burden upon the production of raw material to the extent that it stops production will be felt in every line of industry and if the burden is too great will cause a collapse of the industry. We can not too strongly protest the theory upon which this decision is based, nor too strongly protest the theory upon which the Hoke Smith bill was passed by Congress.

The North and South Wind

PRESIDENT HOOVER has issued an appeal urging massed attack against legislation proposing to raid the Treasury at the next session of Congress. His appeal has struck at the core of the problem of vast governmental expenditures, for while the last Congress was dubbed wasteful, while it passed an unprecedented number of bills, while it earned the title of spendthrift, and while it did many things unwisely, it, nevertheless, did them all because of the demand of organized constituents. Congressmen are not supermen. They are not elected to office because they fly in the face of the demands of their fellow-citizens but because they agree with them. Their very function demands that they agree with the people whom they represent.

Behind every bill that finally becomes a law there is a vast amount of pressure, a well-organized majority or minority, a definite demand. Congress is but a reflection, a cross-section of the viewpoint of the American people. President Hoover's appeal should meet with individual support and agreement, and we hope will be heeded by the country as a whole.

The Mountain and the Mouse

A RECENT compilation of the current statistics of the Electric Light and Power Industry issued by the National Electric Light Association presents many facts, somewhat startling to those who have not followed the industry with care.

To begin with, the value of plant equipment of the industry in the United States is estimated at $12,500,000,000. During the month of August, 1931, the industry produced more than seven billion kw. hours; only one-third of which were produced by water power. Of the seven billion kw. hours produced, more than one billion is lost in transmission.

During the 12 months ending August 31, 1931, fuel produced nearly fifty-nine billion kw. and water power twenty-seven billion kw. During that year fourteen billion kw. hours were lost in transmission, most of which could have been avoided by the use of larger transmission wires. Out of eighty-six billion kw. hours produced, seventy-three billion kw. were sold to the consumers for a consideration of $1,983,000,000.

According to this report 85,000,000 people are served by electricty, or 70 percent of the total number of homes in America. This power was delivered over 208,000,000 miles of wire carrying a voltage of 11,000 or greater. Incidentally these figures question the sincerity of those public officials who are attracting public attention by criticism of the water power interests, when less than one-third of the electric power is created by water power. It would seem that this development only serves to make possible cheaper power to the consumer, rather than to be a necessary adjunct to electric power distribution. If two-thirds of the power used in this country can be developed from coal on a competitive basis it would not be too great a strain upon the imagination to assume that all of it could come from the same source. In view of the fact that rates to be charged by the Public Utilities Commission can be locally fixed by each of the separate states the danger to the public does not seem so great as some of our agitating friends would try to make us believe.

After a withering fire of investigation whose record reaches thousands of pages and has cost the taxpayer tens of thousands of dollars over a period of two years, the Federal Trade Commission reported it was unable to find any evidence of a power trust, and that no one company, group, or combination controls more than 12 percent of the Nation's electric energy. Verily, "the mountain labored and brought forth a mouse." Yet the investigation goes on and the taxpayer foots the bill.

Will Rogers on Financial Giants

MONEY is the life blood of commerce. This has been repeated so often that, so far as the public consciousness is concerned, it has become a mere platitude—true enough but of no present concern. And yet, the present world depression makes of it the most startling statement.

Will Rogers strikes at the gist of the situation when he says:

"We got all the gold over here and look how pretty we are sitting. Yeah! It looks like the financial giants of the world have bungled as much as the diplomats and the politicians. This would be a great time in the world for some man to come along that knew something."

Even Great Britain, with all of her background of world financial control, is urging a world conference on gold. She will do better to ask for a world conference on money. Apply Will Rogers' reference to the past financial leaders of Great Britain and its triteness will find proof in the present day situation.

With half the gold of the world, the United States would seem to be in a commanding position—in the position which Great Britain planned for herself and which she held for so many years. But her scepter has departed; and whence? To the United States at one time enthralled as a debtor nation. Now as a creditor nation she is unhappy because she has too much gold. If she had all the world's gold, she would be unhappier still, because other nations would quickly learn to get along without gold; its value in world trade would vanish and its value at home would serve no purpose higher than government approved paper money.

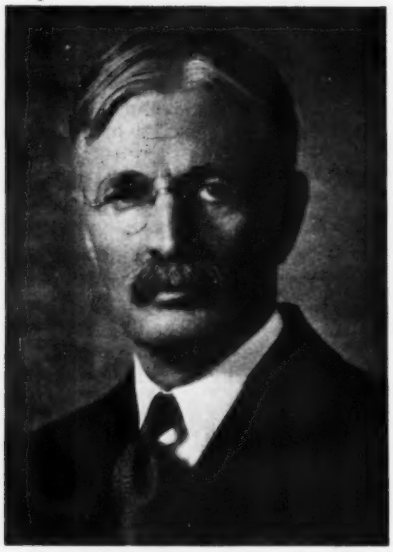
Maldistribution of gold is almost as dangerous as demonetization of gold. The greater the concentration of gold, the less its use or value in world trade. Gold will lose most of its value whenever means are devised for the conduct of world trade without its use. Such transactions grow more inevitable as the world's gold supply is more completely concentrated. Already the coal miners of Colorado are trading coal with the farmers of Kansas for wheat. The barter system of trade is exceedingly cumbersome but it is better than no system.

The conclusion of Will Rogers that our financial leaders have failed is more than a joke. It is a tragedy.

Rights

NOT so many years ago the American Federation of Labor waged a vigorous battle in favor of their belief in the right to strike. Today the same organization is as vigorously undertaking to establish the principle of the right to work. Both of these campaigns conducted in the interest of the working man but serve to denote the signs of the times. When the now famous slogan "the right to strike" was advanced, labor was fully employed. Industry was prosperous. Labor felt then that it was entitled to a larger share in the profits of industry, and set out to obtain it through persuasion or through strikes. President Green of the Federation advanced the new slogan, "the right to work," at his recent Vancouver address, and at a time when industry is at low ebb and labor seeking jobs but accepting, perhaps unwillingly, charity.

We took issue with the Federation in its original campaign in favor of the right to strike, insisting that the "right to strike is a qualified right, which ceases and becomes a conspiracy against the Government when it interferes with the production and distribution of the necessities of life." We do not take issue with their present slogan of "the right to work." But rights, as such, are necessarily tempered to the need. The world owes nobody a living, but industry does owe those dependent upon it every opportunity to work and to become self-respecting, self-reliant citizens. Equally, labor owes industry its best service for its wage. A dictatorial attitude on the part of either capital or labor is undesirable at all times, and particularly at this time, when the world needs cooperation and full team work to climb over the top of the hill. The "right" of industry, or the "right" of labor is of small importance in an emergency. All rights are qualified.



THE LEAD SITUATION

By Clinton H. Crane*

LEAD MINING in the United States is down to less than 35,000 tons monthly, which is virtually back to a 1913, or pre-war, rate of production, and marks a drastic adjustment to present poor business conditions. A persistent decline in the price of lead for over 19 months, which ended in June, to phenomenally low levels in Londan (at one time 2.25 cents per pound), and extremely low prices in St. Louis and New York, have brought this about. Even though there was a slight betterment in the lead market in the latter part of June no tendency to increase production is apparent from the moderate improvement that occurred. Prices are still unattractive to producers.

As the fortunes of most lead mines, especially those in the Cordilleran belt, are intimately interwoven with the course of the silver as well as the lead market, an added discomfort has been the distressingly low prices received for this precious by-product. Without doubt the simultaneously poor silver market has had an important part to play in causing numerous lead mines to suspend operations entirely.

Production has decreased largely through the pressure exerted on the market by the heavy stocks of lead steadily accumulated in the hands of sellers here and abroad. World stocks of lead which amounted roughly to 250,000 tons in the spring of 1930—then considered high—now total about 425,000 tons. No better evidence is required of a world-wide unwillingness to consume the metal. Yet in the face of this condition country after country, outside the United States, has steadfastly adhered to a high production schedule, with the natural result—a rapidly declining market price for lead.

The accompanying table illustrates approximately the adjustment to present conditions which have been made by the principal lead producing countries of the world. The United States has made by far the greatest cut in production and other countries are only slowly following suit. As the comparison is made for only two months, June and July, 1931, compared with June and July, 1929, considerable latitude should be used interpreting the results. If a similar comparison had been made earlier in the year, it would have shown an even smaller tendency on the part of many foreign countries to decrease production. Whatever foreign production adjustment has taken place lately is doubtless mainly the outcome of a decision by foreign lead producers to curtail production 20 percent, as recently announced.

Production of domestically mined lead, including antimonial lead, in the United States in the last few months has been at a rate of about 410,000 tons annually, compared with an output of 689,500 tons in 1929, 577,000 tons in 1930 and 427,000 tons in 1913, which is a measure of how domestic production has been adjusted to the poor appetite of consumers for lead. Unless the world is to return to a pre-war rate for the production of all its raw materials—an absurd idea—the present rate of domestic output should not long continue.

ADJUSTMENTS IN WORLD PRODUCTION*

	Daily Production Rate (In Tons)		
	June & July, 1929	June & July, 1931	Percent increase or decrease
United States	1,877	1,030	—45
Canada	444	355	—20
Mexico	856	648	—24
Spain and Tunis....	319	246	—23
Germany	293	306	+ 4.4
Australia	537	412	—23
Burma	243	221	— 9
Others	801	616	—23
Total.....	5,370	3,834	—28.6

* Based upon statistics of American Bureau of Metal Statistics.

The history of the domestic lead market shows that for 28 years prior to the war, from 1885 to 1913, the average rate

* President, St. Joseph Lead Company; President, Lead Industries Association.

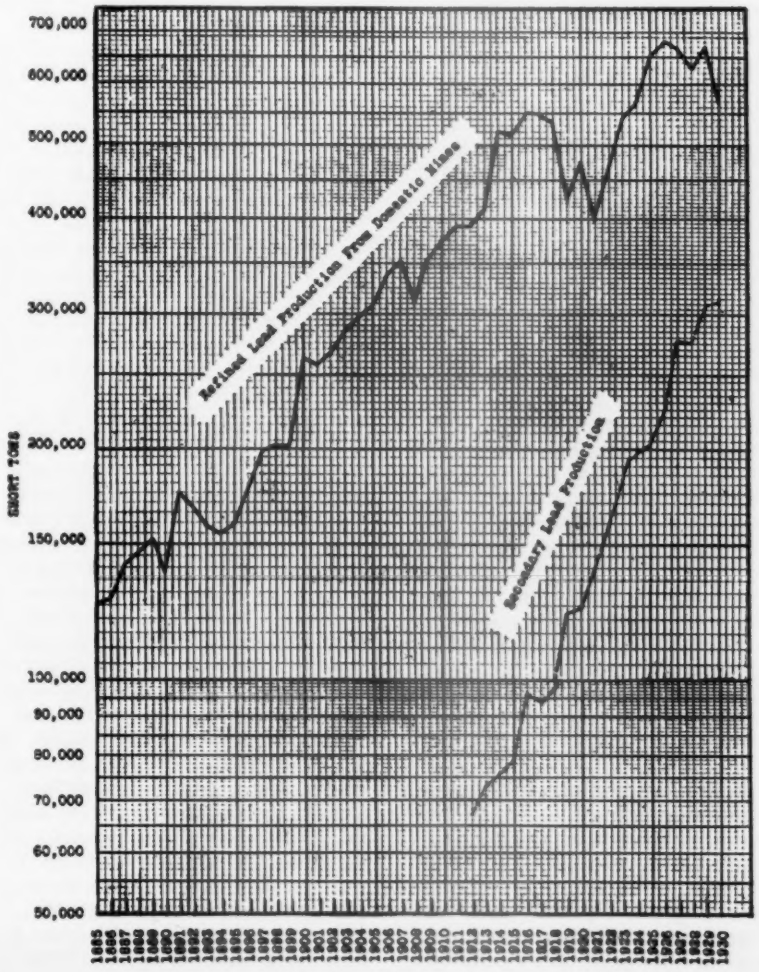
of increase in lead output was about 4.3 percent per annum. The war upset everything. Production of the war metal in the United States was stimulated enormously and reached heights previously unheard of. In one year, 1916, 552,000 tons of lead was produced, exclusive of antimonial lead, but the output fell off rapidly to the post-war slump of 1921, when 398,000 tons was mined. Probably very few people visualized then the strong recovery which was to be made by lead during the following five years again bringing production to a record high in 1926 of 680,000 tons.

The accompanying diagram shows rather vividly how the war disturbed the fairly even growth of American lead production. Had the pre-war rate of output continued we should have been producing, in the past few years, a much greater amount of lead than we actually mined. Owing to the ever widening use of machinery, such as automobiles, telephones and the like, into the manufacture of which lead enters directly or indirectly, the per capita consumption of lead has increased greatly since 1913 when it amounted to 8.75 lbs. per capita, compared with 12.05 lbs. per capita in 1929. The diagram also shows the rapid increase in the production of lead from secondary or scrap sources that has occurred in the last 15 years—a faster rate of growth than that of virgin lead production, and prophetic of the increasingly significant role which secondary lead will play in the general market situation.

The very fact that American lead production is so heavily curtailed today that a rate comparable to pre-war periods prevails, is a good indication that, once business turns for the better, the ground to be regained will be rapidly recovered and production again placed on an advancing scale. It should only be a few years before the demand for virgin lead from American mines will exceed 800,000 tons annually. The only thing which would tend to halt this growth is a static population in the United States, something not apparent as yet, or such high prices of lead that consumption would be restricted.

One important compensation for the abnormally low price of lead, and this applies with equal force to copper and zinc, is the stimulus which will be given to their wider use in competition not only with cheaper iron metals but also with the more expensive non-ferrous metals that have not shown much recession in price the last year or two. Lead comes into competition with practically all other metals and a great many non-metallic substances. The low price of lead makes it easier for the lead storage battery to compete with the nickel-iron battery, for lead foil to compete with aluminum foil, and with paint pigments other than lead, and so on throughout industry.

Just as the history of the metal market shows that abnormally high prices of the metals generally do not last long and generate forces which bring about their own and drastic undoing, just so will the extraordinarily low prices of the non-ferrous metals probably hold the stage for only a brief interval. They, too, generate forces that start an upward trend. Price is a remarkable natural regulator of economic machinery but it is extremely unfortunate that business has to go through periods of disaster and forced reorganization in using it.



Lead is not sold like automobiles or refrigerators, for which a demand often may be created at the expense of other finished goods. Lead is a basic raw material which reflects the state of trade in dozens upon dozens of individual industries, nearly all admittedly suffering from subnormal outlets. Ideally it would be desirable for production to be regularly adjusted to consumption, but this ideal is seldom accomplished either nationally or internationally. Corporations and countries are prone to look at business conditions from their own circumscribed viewpoint. Hence it is common to find corporations in all producing countries going ahead full blast regardless of the obvious unwillingness of the market to consume lead—or for that matter other products—at anything like the normal rate of consumption. But this practice generally brings its own retribution for, as the market yields, even those who operate at capacity feel the pinch. It is noteworthy of late that some foreign countries where over-production has been most noticeable are finally bringing production in line with consumption, a situation doubtless finally forced upon them by the bitter medicine of a 2.3 cent lead market in London.

Despite the great amount of criticism heaped upon the tariff, the lead mining industry of the United States would be in sore straits today without protection. It is doubtful if any domestic lead mines could operate long on a 2.25 cent price level for lead without cutting labor to an unprecedented degree. One advantage of the tariff not ordinarily considered is that it gives (*Continued on page* 596)

OUTLOOK FOR ZINC

By A. P. Cobb*

WHEN THE MINING CONGRESS JOURNAL suggested some months ago that I write a few words on the Outlook for Zinc in 1931, any forecast for the immediate future would have been largely guess work. As the article takes form, there are many concrete facts and numberless and imposing graphs on which to base predictions. Nineteen hundred and thirty-one is three-quarters gone, however, and is irrevocably branded an uninteresting year in countless other industries besides zinc. So let us look a bit further ahead, for there are many things of interest awaiting an increased tempo of business activity. We shall speak first of the metal and its various uses, and later talk of the zinc sulphide pigments and the zinc oxide pigments and their future outlook.

In boom times, as well as in times of depression, a large part of the annual production of metallic zinc is used in galvanizing—"zinc-coating" we in the zinc industry like to call it. It is the principal use for prime western slab zinc—often called "common metal"—and common metal is made in larger quantities and by more smelters than any other grade of slab zinc. Today the American Zinc Institute is studying the advantages of more heavily zinc-coated sheets. Manufacturers of sheet steel are lending valuable cooperation. With the experience of the Sheet Metal Council of Canada as a guide, and their results as a yard stick, I feel at liberty to prophesy that the use of zinc for galvanizing will increase, although results from this study can not be expected to show much in 1931.

For special zinc-coating jobs, where sheets or wire are to be formed after galvanizing, it is necessary to employ high grade zinc. Absence of appreciable amounts of those impurities inevitably present in prime western metal assures the ductility which is required. The large amount of road construction fostered by Federal and state governments is using quantities of zinc-coated culverts and suspension bridges, which—without exception—from the old Brooklyn Bridge to the new George Washington Bridge spanning the Hudson between Manhattan Island and New Jersey, have used Horse Head Zinc to protect their cable wires. Research more and more shows the economy in paying a premium for high grade metal for use in various fields, and this angle is the interesting one when looking into the future. As the company with which I am connected does not sell prime western metal, I am more particularly acquainted with the market for higher grades, and the uses will be discussed largely from this angle.

The reader is familiar with the quotations on copper and zinc. As I write, they are close to their lowest points in our present industrial era. Brass is consequently selling at a price making it attractive for uses where its normal cost has formerly ruled it out. Of course, many manufacturers will hesitate to adopt brass on the basis of its present price level where a rise in price would change the competitive situation, but it certainly removes the threat of substitution of other materials where brass is now established. The low degree of activity in many industries which formerly were big consumers of brass, however, has reduced this outlet for both high grade and prime western zinc to a fraction of the usual tonnage.

The market for rolled zinc has had its ups and downs with less relation to general business conditions than is true of most other outlets for this most economical of non-ferrous metals. Today the large scale electrification of eastern railroad lines is using a considerable amount for signal cable wrapping. An increasing use in radios will probably result from zinc's non-magnetic properties and low price. And while its use in batteries has recently decreased because of the development of the electric set, we find the returning style of wearing corsets is booming the manufacture of eyelets. Incidentally, the tonnage used for eyelets, grommets, shoe lace tips, and smaller comparatively stable miscellaneous items is surprising. More directly related to production and consumption, and gaining a greater percentage annually in the production of motor cars, is the use of rolled zinc for automobile running board moulding.

The plating of rolled zinc and zinc die-castings here deserves a word, for upon its ability to take finishes properly depends the future expansion of markets. Much work has been done in the past few years relative to the finishing properties of zinc base die-castings and the results have been most gratifying. Almost any type of finish may be applied, any kind of electroplated coating—whether it be nickel, chromium, copper, brass, cadmium, silver or gold, enamels and lacquers. With the smooth, fine grained surface obtained on die-castings of zinc alloys, very little work is necessary in the preparation of the casting for plating—a slight buffing and polishing operation, and a non-rusting white zinc-base alloy is ready for an attractive plating of the type selected.

The automobile manufacturers have been most progressive in utilizing the

* Vice President, the New Jersey Zinc Company.

sales appeal of the various improved platings now available. Exterior automobile hardware is usually finished in beautiful, bright chromium white; the inside pieces may be made to blend with the interior body work by executing in dull nickel or chromium—sometimes even in a quiet brown or gray.

Outside the automotive field, refrigerator hardware is finished in bright chromium, dull chromium or dull nickel. Clock housings are done in dull nickel which gives the appearance of pewter. The brilliant colors or soft tones of lacquers and enamels may also be applied to zinc and zinc alloys. Combinations of plating and enamel or lacquer have been effectively used in pointing up the modern designs of automotive and builders' hardware. Household hardware may be executed in brass or bronze to harmonize with other fittings, although there is a decided trend towards the use of white metal hardware. This growing popularity for white metal finishes has increased the demand for white metal alloys such as those made with a zinc base.

It was not until 1926 that the American Bureau of Metal Statistics separated the use of zinc for die castings from the miscellaneous uses column. The future outlook for this industry, however, seems to deserve special mention—particularly in view of the rapid annual increase in its importance from the tonnage standpoint. Industrial demand for a better product to sell at a lower cost being almost universal, it is the good fortune of zinc die-casting to be the process to fill the demand. Even before the research work of the New Jersey Zinc Company provided the alloys which are now the basis of commercial practice, the possibilities of the process had caused a rather wide use of a number of zinc alloys of more or less trustworthy performance. Today one of the biggest obstacles to be overcome in expanding the use of zinc die-castings is to dissipate the prejudice left in certain quarters from unfortunate experiences with these early alloys.

But little explanation is needed to show that present alloys—and their performance—are far different from the earlier. For certain of these new alloys Horse Head Special 99.99+ percent zinc, a "purity metal" even purer than the famous Horse Head Zinc which has been the standard for uniform quality high grade zinc for so many years, is used. When research showed the necessity for "purity metal," manufacturing genius learned how to meet the demand with an outstanding development in the pyrometallurgy of zinc.

Another line of development is the perfecting of new zinc alloys suitable for service in fields where the present alloys have not all the qualities required. Since the inception of our intensive study of zinc alloys for die-casting, the resolution not to recommend any alloys for use where they will not be satisfactory has been paramount. The worth of our research work to many industries, as well as to others who make high purity metal, is proved by the growing list of important industries now using zinc-base die-castings. And the outlook for the future is one of the brightest spots in the zinc industry.

A few months ago one of our research men spoke before the annual meeting of the American Zinc Institute at St. Louis on the future of zinc pigments in paint. Partly because the Joplin ores are largely zinc sulphide, the audience was greatly interested in the talk, which had to do with the great importance assumed by the zinc sulphide pigments. Actually, zinc sulphide pigments are not derived directly from zinc sulphide ores. The production of straight zinc sulphide is a process involving the purification of zinc liquors before the zinc sulphide is finally precipitated out.

It is often a surprise to those outside the paint industry to learn that lithopone (which contains 28 to 30 percent zinc sulphide) is the most used white paint pigment, but this is the growth the Government figures show: from 5,000 tons in 1903, largely imported from Europe, to a top figure of 206,000 tons in 1929, with imports negligible. Last year's figure was 164,000 tons—a really remarkable showing when 1930 conditions are considered.

Ever since light resistant lithopone was perfected by the New Jersey Zinc Company in 1920, enabling paint manufacturers to use it in exterior paints, the use of this pigment has made tremendous strides. When properly formulated by paint manufacturers, with the correct proportions of zinc oxide, inerts and vehicle, it makes a paint which gives first grade performance. Both zinc sulphide pigments and zinc oxide pigments are naturally and permanently white, which is a primary requirement for the base of modern white and light tint paints. Scientific formulation produces zinc pigment paints which chalk slowly, leaving a good surface for repainting. Every exterior paint should chalk to some extent since any other method of wear would result in a surface unfit for repainting. The slower chalking of zinc pigment paints means economy. Because the pigments are white, the tints are clear and bright, and the slow rate of chalking does not change the color of the tint during the life of the paint.

In lithopone paints more covering power may be bought for a dollar than is possible with any other type of paint. This caused paint manufacturers to base their interior wall paints on lithopone long before it was suitable for exposure out of doors. Continued improvement in lithopone and increased knowledge of paint formulation have given paints based on lithopone an outstanding position in exterior work. When you realize that lithopone is 28 to 30 percent zinc sulphide, it can be seen how great an amount of zinc is consumed annually in such paints.

Then there is the high zinc sulphide pigment field, in which the New Jersey Zinc Company has pioneered with its Cryptones. The consumption is smaller by far than that of lithopone, but the Cryptones contain nearly twice as much zinc sulphide. Barium-base Cryptone, a lithopone type of pigment, was introduced because our studies of outside house paint indicated that as the zinc sulphide content of the paint is increased the better the paint will be, provided the zinc sulphide is supplemented with the proper combination of other pigments in a correct vehicle. The zinc sulphide lends greater powers of resistance to disintegration, due partly to greater capacity to the ultra violet rays, and the paint remains intact for a longer time.

While on the subject of high zinc sulphide pigments, let us devote a few lines to straight zinc sulphide—a pigment about which a lot more will be heard as the years roll by. Work done with this pigment further supports the showing of Cryptone. Paints formulated with an ever higher zinc sulphide content than those made with a normally high zinc sulphide pigment show a further advance in durability, a further increase in hiding power and the retention of the other good qualities characteristic of high zinc sulphide pigment.

Within the last few months a new Cryptone for interior use has been introduced. Here the useful zinc sulphide appears in combination with calcium sulphate. Flat wall paints and undercoaters based on this Cryptone are high in hiding power, unusually flat, have superior leveling, and are washable. With these advantages they also offer excellent brightness and high light reflection. Such a combination of qualities augurs well for the future.

To those at all familiar with paint technology, zinc oxide is a fixture. The extra durability it gives to all paint films, with washability to wall paints and slower chalking to outside house paints, are fully appreciated. As the only paint pigment possessing certain characteristics necessary in popular types of high grade paint and enamel finishes, its future is secure.

A discussion of zinc pigments in paint would not be complete without mention-

ing a paint of interest to every man connected with industry, for it is remarkable in its rust inhibitive properties. References to experiments with zinc dust as a pigment in paints date back to 1840. At first, attempts were made to use it alone in linseed oil vehicles; and while excellent exposure results were obtained, the high specific gravity of the material led to certain practical difficulties, such as rapid settling to the bottom of the container. More recently, this difficulty has been completely overcome by the addition of zinc oxide to the pigment formula.

Evidence of the superior protective and adhering qualities of zinc dust-zinc oxide paints on metal has been presented from time to time by our laboratory, but I do not believe it is necessary to enter into any detailed discussion of our experiments with the product during the past eight or nine years. It is more efficient as a corrosion-resisting paint than any other standard metal priming paint.

One characteristic noted when zinc dust-zinc oxide paint is used on black iron or steel is the tenacity with which the priming coat adheres to the metal. Our earliest experiments on galvanized iron and sheet zinc indicated that this characteristic of the paint would be of value in this field. In fact, considering the simplicity of the formula, some exceptional results have been obtained on such surfaces even without pre-treatment or cleaning and etching of the surface, which is ordinarily considered so essential for the best results. We do not wish to belittle the value of cleaning (i. e., removing grease, etc.), new zinc surfaces that are to be painted, and an etched surface is undoubtedly an aid to the adherence of any paint; but whenever careful cleaning and etching are impossible, this paint can be counted upon to show a high degree of adherence as compared with other paints.

WATCH ZINC, both metals and pigments. In certain instances there is evident a coordination between sales, research, and production which can only mean progress. And where the characteristics of materials are as interesting as zinc metals and alloys and pigments, a progressive spirit means continued expansion.

THE LEAD SITUATION

(*From page 593*)

the domestic lead miner a certain degree of immunity from the failure of foreign countries to adjust their output in line with consumption and consequently forcing the foreign price to ruinously low levels. We are at least enabled to reap some benefit from the protective tariff regardless of how far the attitude of foreign producers depresses the market. At times, however, overproduction in the United States has prevented the domestic lead miner from keeping the full benefit of the tariff as the domestic price has been forced to within a short distance of the London level.

The virgin lead situation is complicated by the growing importance of secondary or scrap lead. Lead is easily reclaimed from several important uses, such as storage batteries or lead-covered cable. A huge amount of lead circulates in the storage battery industry alone. Many storage batteries are produced with metallic parts constructed entirely of lead from secondary sources. One of the inducements to using lead is its salvage value. Important businesses have been developed based upon the recovery and sale of secondary metals. Metallurgical practice has so improved in recent years in the scrap field that the quality of the product made from secondary metal has correspondingly improved. The smelting and refining of secondary lead is now an integral operation of nearly all primary lead producers. So severe is the competition from articles manufactured with secondary lead that, in some lines, for example, calking lead, it is extremely difficult for the manufacturer using virgin lead to compete. In the last 12 months, secondary metal manufacturers have had a trying time conducting their business in a steadily falling metal market.

It does not take much acumen to infer that the future of lead is secure even though the picture looks black at the moment. Nature distributed this remarkably useful metal plentifully enough so that it could be produced at a very reasonable price and its valuable physical and chemical characteristics used to advantage. There is nothing on the horizon calculated to disturb the present high technical efficiency of lead production; nothing comparable to selective flotation and its effect on the cost of producing lead. There have been no extraordinary lead fields discovered large enough to provide potentially huge and new sources of the metal at low cost. Those mines that are being added to existing supplies, such as Mt. Isa in Australia, or some South American possibilities, must be expected if the world is to be furnished with growing amounts of lead at fair prices. The newer fields in some cases merely make up for the depletion and abandonment of older properties.

At the same time there is every reason to believe that lead will continue to possess unusually diversified outlets which, if anything, should tend to increase. Of interest in this connection is the fact that lead is not only valuable for the characteristics of the metal itself but also by reason of the utility of a great many easily manufactured lead compounds, such as white lead, red lead, litharge, orange mineral and many others. About 30 percent of the domestic consumption of lead takes place in a chemical form—a higher ratio than in the copper or zinc industries.

As the world population grows and the standard of living increases not alone in the United States but elsewhere in the world, the demand for the metals will increase, and lead will share in this demand. (It is staggering to contemplate the improvement in the standard of living that is possible even in Europe, not to mention Asia.) Human wants are never satisfied, and the average urge to improve one's lot will result in an ever increasing demand for goods.

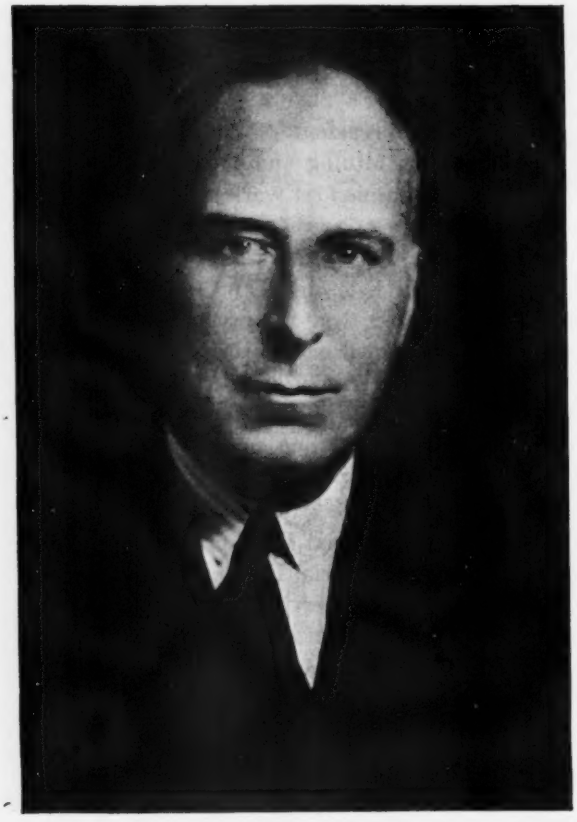
Portal of Kellogg tunnel, Bunker Hill Mine, showing shift train

Frederick Worthen Bradley

President of the Bunker Hill & Sullivan Mining and Concentrating Company

MR. FREDERICK WORTHEN BRADLEY, president of the Bunker Hill & Sullivan Mining and Concentrating Company, did his first work at the Bunker Hill mine as engineer during the year 1890, he succeeded to the office of manager in 1893 and was elected president in 1897, which office he has continuously held since, and with William H. Crocker, treasurer, and Stanly A. Easton, first vice president, constitutes the executive committee of the board of directors of the Bunker Hill & Sullivan Mining and Concentrating Company. In addition, Mr. Bradley is president of the Alaska Juneau Gold Mining Co., Alaska Mexican Gold Mining Co., Alaska Treadwell Gold Mining Co., Alaska United Gold Mining Co., Ocean Shore Railway Co., Registration and Securities Co., Treadwell Yukon Co.; vice president of the Atolia Mining Co.; director of the Golden Gate Gold Mining Co., First National Bank of Juneau, Juneau Realty Co., American Trust Co., Atlas Imperial Diesel Engine Co., Occidental Insurance Co., San Francisco Commercial Co., Spanish Mining Co., Sullivan Mining Co.; past president of the American Institute of Mining and Metallurgical Engineers. He is held in highest regard by a world-wide group of mining people and the mining and engineering profession in general. The Crocker Building, San Francisco, Calif., is the headquarters of Mr. Bradley and his engineering organization, and has been for over 30 years, during which his intense activities have extended into every branch of mining and metallurgy.

A view showing the topography of the Wardner Mining District. The Bunker Hill ore bodies lie under the ridge immediately in front of the snow-capped Kellogg peak. The Bunker Hill Smelter is in the foreground and the stack of the Sullivan Zinc Plant is on the right center



Foreword

By Stanly A. Easton

Vice President and Manager, Bunker Hill & Sullivan Mining and Concentrating Company

BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY

THE OPERATIONS of the Bunker Hill & Sullivan Mining and Concentrating Company, Kellogg, Shoshone County, in the Coeur d'Alene mining district of northern Idaho, are the mining, reduction and sale of the ores from a compact group first known as the Bunker Hill, Sullivan, Stemwinder, Tyler, Last Chance, Sierra Nevada, Caledonia and other mines, an area of some three thousand acres of mineral land and have been well known to the mining profession and the public for over 30 years.

The up-to-date description of the mining methods, metallurgy and affiliated operations given in the following papers are especially note worthy, and without doubt are the most complete and accurate descriptions that have ever appeared. All of the men who contribute to this unusual collection are technicians of sound experience and ability; because of their long acquaintanceship with the work described, much of which has been entirely developed under their direction, they are able to write authoritatively of the subjects dealt with. I consider their treatment of the subject-matter of the various papers to be of the utmost value to the profession.

The operations of the Bunker Hill & Sullivan Mining and Concentrating Company are best known for the long period of uniform and regular productivity which extends over four decades, during which time many important and interesting practices have been developed both in its mines and metallurgical establishments. A like important circumstance is the diversity of the product of the operation and the fact that it is all accomplished at one place by one organization, there are produced from its own and purchased ores ready for the consumer: Bunker Hill brand 99.99 corroding lead, fine silver, fine gold, and copper bearing by-products; from its affiliated operation, The Northwest Lead Co., manufactured lead products and from the Sullivan Mining Company, Bunker Hill brand 99.99 plus zinc, and the highest grade cadmium on the market.

This accomplishment is the result of years of growth and expansion, all of which has been financed by earnings of the parent mine and almost wholly the result of the research and design of the local staff. All of the above metals are now being produced in the largest quantity and of the utmost purity attained at any time by the Bunker Hill & Sullivan Mining and Concentrating Company. It is unusual that a mining enterprise after so many years of productive life is yet able to display real powers of expansion and growth determined only by the demand and price for its products.

The Bunker Hill and Sullivan Mining and Concentrating Company

By J. W. Gwinn*

HISTORICAL

IDAHO, like most of the other western states, began its mining history with the advent of the placer miner. Among the first gold discoveries in what now comprises the state of Idaho was that made by members of the survey party of Captain John Mullan, in 1858, as they were surveying out a road across what is now the northern part or panhandle of Idaho, from Spokane Falls to the Bitter Root Valley, in Montana, which road was to be a link in the military road extending from Fort Walla Walla to Fort Benton, at the head of navigation on the Missouri River. Prospecting by members of his party was not encouraged by their chief because of the need of completing their work in the mountainous area before the winter season overtook them, consequently their discoveries of gold bearing placers went unheralded at the time.

There was much activity in the Pierce City and Boise Basin districts, beginning in 1860, which attracted a great many miners to the Territory, but profitable gold discoveries were not made in the northern district, now known as the Coeur d'Alene district, until the discovery of gold in Eagle Creek in 1882 by A. J. Pritchard. This discovery induced the usual rush to the district, and within a short time the new mining towns of Murray and Eagle were over-run with miners looking for placer ground. This overpopulation, together with the roaming spirit of the early day prospector, soon led to search farther afield, and it was while on such a trip that Noah S. Kellogg discovered the Bunker Hill galena vein, on the hillside above the present town of Wardner, in Milo gulch, some 30 miles from his base of supplies at Murray, on or about August 26, 1885.

Not knowing the value of his discovery, he showed some of the iron-stained galena croppings to Phil O'Rourke, a former Leadville miner then being grubstaked by Jacob Goetz, who recognized it for what it was. The two of them then located the Bunker Hill claim in O'Rourke's name, with Kellogg as a witness, on September 10, 1885. A few days later, on October 2, Con Sullivan, a friend of O'Rourke, located the Sullivan claim across the gulch, and within a short time the adjacent ground was all located.

Disputes and lawsuits growing out of grubstake agreements that had previously existed between Kellogg and two storekeepers at Murray were finally settled, by giving to the storekeepers, Cooper and Peck, a half interest in the Bunker Hill claim and a quarter interest in the Sullivan claim.

Soon after the discovery, the partners entered into an agreement with Jim Wardner whereby the latter would secure capital for development of the mine and the construction of a mill, Wardner to receive $5 per ton for milling 50,000 tons of ore in the proposed concentrator. Wardner then made a contract with the Selby Smelting Co., to treat the mill product in their smelter at a price that left a good profit to the mine owners. After being assured of the disposal of the product from a mill, he succeeded in interesting a syndicate composed of A. M. Holter, S. T. Houser, A. M. Euster and W. E. Cox, all of Helena, Mont., and D. C. Corbin, of Spokane, who organized under the name of the Helena Concentrating Co. This company built the first mill to treat Bunker Hill ore, and it was located at the mine, on the Sullivan side of the gulch.

This first mill had a capacity of 100 tons per 24 hours, and began operations on July 20, 1886. The cost of operation was about 50 cents per ton of feed, making it a very profitable investment for the Helena Concentrating Co. The mine operations, however, could not be conducted profitably under the existing conditions, including the expense of driving lower tunnels to expose the ore at depth, and the mine owners commissioned Jim Wardner to find a buyer for the mine. After some negotiations, it was sold to Simeon G. Reed, of Portland, Oreg., for $650,000, and for an additional $100,000 the mill and milling contract were included in the transaction, together with a tenth interest in the Sullivan claim.

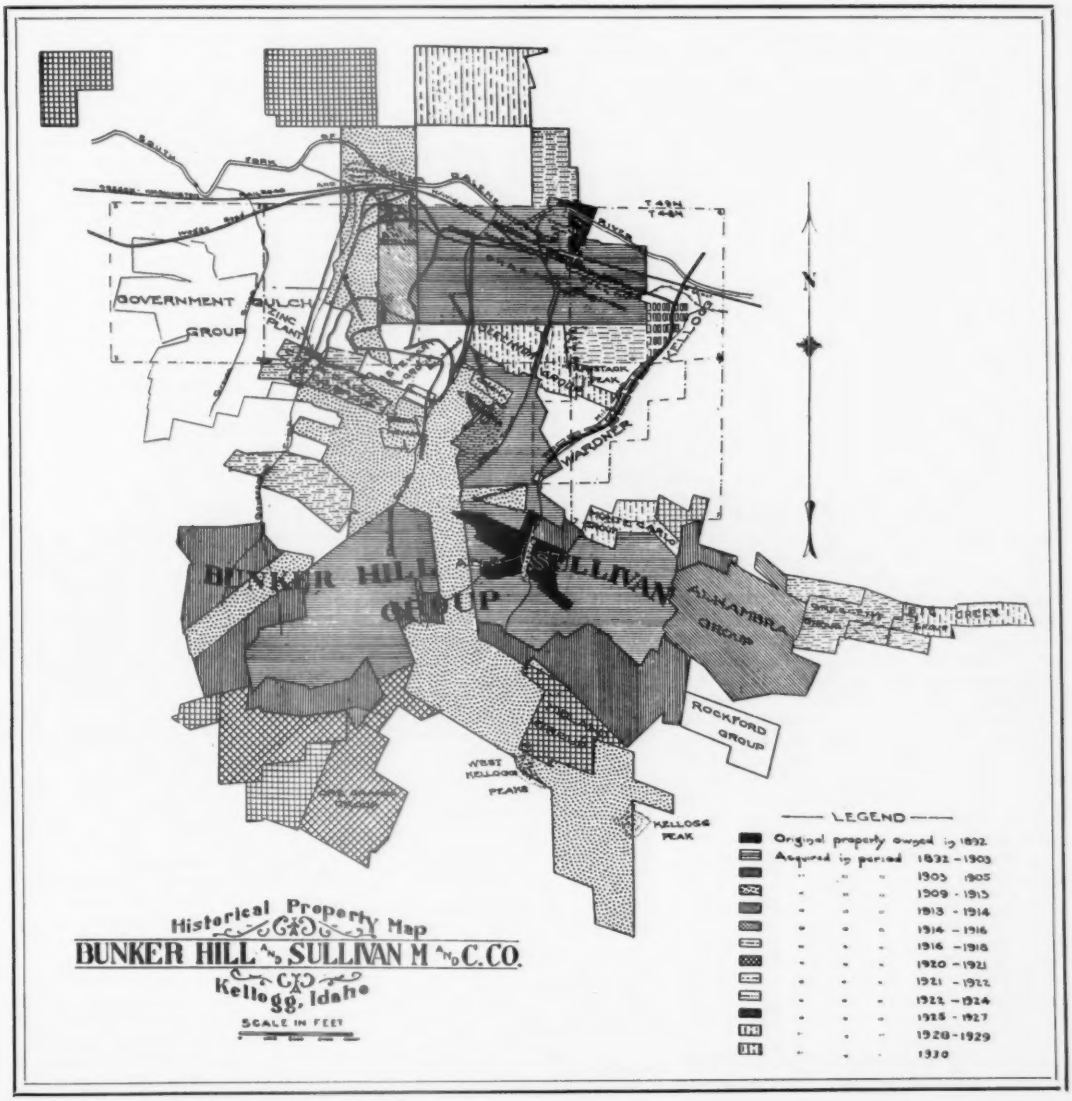
On July 29, 1887, the Bunker Hill & Sullivan Mining & Concentrating Company was incorporated under the laws of the state of Oregon by Mr. Reed, Martin Winch, his secretary, and Noah S. Kellogg. It was capitalized for 300,000 shares at $10 per share, 250,000 shares being issued, all to Mr. Reed except one share each to the other two incorporators. On August 1, 1887, Victor Clement became manager of the newly organized company.

Up to this time the mine had produced 26,855 tons of ore, most of which had been concentrated in the mill built by the Helena Concentrating Co., and the product hauled 12 miles by team to the Old Mission, or head of navigation on the Coeur d'Alene River, where it was transferred to boats and by them carried down the river and thence the length of Coeur d'Alene lake to Coeur d'Alene city, where it was transferred to cars of the Northern Pacific Railroad and shipped to the smelter at Wickes, now East Helena, Mont. Immediately after the sale of the property to Mr. Reed, D. C. Corbin constructed a narrow gauge railroad from the Old Mission through the present site of the town of Kellogg to Wallace, and this road was soon extended to the towns of Burke and Mullan. This narrow gauge railroad was the forerunner of railroad transportation through the district from Spokane on the west to Montana connections on the east, and at the time of its construction it reduced the length of ore haul by team from 12 to two miles, and greatly reduced the cost of production to the Bunker Hill owners during the early period of mine development when operating profits were small and the extent of the ore bodies was unknown.

As the known tonnage of ore in the mine increased, it became apparent that a mill of larger capacity was needed, and in 1891 a new mill of 400 tons capacity was built in the main valley, below the confluence of Milo Creek with the South Fork of the Coeur d'Alene River, at what is now part of Kellogg, the ore being delivered to it by means of a Bleichert tramway, having a length of 10,000 feet. During this period the Reed tunnel was driven to gain additional depth and to facilitate handling of the broken ore.

With the additional expense of these improvements, together with the cost of pur-

* Mining Engineer, Bunker Hill & Sullivan M. & C. Co.



chasing several adjoining mining claims, it again became necessary to secure financial assistance, although the operating profit up to May 31, 1892, from 213,108 tons of ore, was $899,600 and the assets of the company had increased to $3,483,227. In order to raise $300,000 of working capital, Mr. Reed commissioned John Hays Hammond to raise this amount. This he did by selling stock, or floating loans with stock as security, and in most cases, giving an option to purchase. By this means the company was financed by men who later became the substantial and leading stockholders. Mr. Reed gradually decreased his holdings, until on June 2, 1893, he sold his last remaining shares. Among the financiers who became large stockholders during this period, many of whom still retain large interests in the company, were John Hays Hammond, D. O. Mills, James H. Houghteling, W. H. Crocker, General N. H. Harris, Victor Clement and Cyrus H. McCormick.

After Mr. Reed ceased to be a stockholder, he was succeeded to the presidency of the company by John Hays Hammond, who served in that capacity from July 2, 1891, to June 15, 1893, when he resigned to accept a position in South Africa, to which place he was accompanied by Victor Clement, retiring manager. General N. H. Harris succeeded Mr. Hammond as president on June 15, 1893, and F. W. Bradley succeeded Mr. Clement as manager on March 20, 1893. At this time the company was heavily in debt and the ore reserves were smaller than they have ever been since that time, making the outlook for the future success of the property anything but bright. On June 17, 1897, F. W. Bradley became president, which position he still retains. He also held the position of manager concurrently, with Frederick Burbidge serving as acting manager, until June 1, 1901, when Albert Burch was appointed to the position of manager, which he held until January 1, 1903, when he was succeeded by Stanly A. Easton, the present vice president and general manager, who has served continuously since that time. In 1905 William McDougall became superintendent, which position he still retains. Thus, for more than a quarter of a century, the successful growth and expansion of the company has been directed by these three men, to whom the successful record is a lasting monument of achievement and ability.

For the purpose of cutting the orebodies at a greater depth and providing transportation facilities for men and supplies, as well as economical ore transportation to the mill, the Kellogg tunnel was started in 1897, and it intersected the Bunker Hill ore shoot in 1904, 10,000 ft. from the portal. With the completion of the tunnel and the connecting raises to the upper workings, the use of the tramway was discontinued, and the town of Kellogg succeeded Wardner as the headquarters for operations and as the center of homes for employes as well as the business center of the community. The Kellogg tunnel cuts the orebody at a vertical depth of about 1,500 ft. below the original discovery and a distance of

approximately 2,250 ft. below the discovery on the slope or dip of the vein.

During the time the tunnel work was in progress, labor troubles interrupted the work of the mine. The mill at Kellogg, known as the old south mill, was dynamited on April 29, 1899, and milling operations were interrupted until a new mill could be built and equipped. The new mill was placed in operation early in 1900.

After completion of the Kellogg tunnel in 1904, vigorous exploration work was undertaken on the tunnel level and the intervening ground between it and the surface not already explored and stoped, for the purpose of locating and outlining the orebodies, which campaign resulted in opening up the Carey and July stopes on the 7th and 8th levels, and the March orebody on the tunnel or No. 9 level, three of the highest grade and most productive stopes in the history of the mine. These new orebodies were responsible for increasing the amount of the annual dividend from $211,000 per year for a seven-year period, to $2,100,000 per year for a four-year period, and was the beginning of the profitable era of the company which has marked its operations since that time.

In 1905 the sinking of an inclined shaft from the Kellogg tunnel level was commenced, and levels were established at intervals of 200 feet vertical depth. Shaft sinking and development of levels therefrom proceeded only as rapidly as the exhaustion of orebodies from older upper levels made it necessary to insure the required tonnage and maintain economical mining practise.

In 1898 the Bunker Hill & Sullivan Mining and Concentrating Co. and the Alaska Treadwell Company each purchased 31.34 percent of the stock of the Tacoma smelter on Puget Sound, rehabilitated the plant, and thereby provided a plant for smelting the ores from these two properties. This ownership continued until 1905, when the plant was sold to the American Smelting and Refining Co. at a substantial profit. The sale of the smelter also carried with it a contract for the reduction of the Bunker Hill ore for a period of 25 years, adjustments to be made in rates at five-year intervals, as conditions made such adjustments advisable. After about 10 years of operation under the terms of this contract, the Bunker Hill & Sullivan company determined that to build and operate a smelter of their own would not violate the terms of their contract. They therefore began the construction of a lead smelter at Bradley, Idaho, two miles west of Kellogg. When initial operation of the plant began in July, 1917, the A. S. & R. Co. attempted to secure a permanent injunction against its operation, the outcome of which was a compromise whereby the Bunker Hill would ship half their production to the A. S. & R. Co. until the expiration of the original 25-year contract period, which ended in 1930, since which time the entire production has been treated in the company's own smelter.

The development and adoption of latest milling practise has always kept step with the industry, and with the changing conditions of the mine production. The South mill, rebuilt in 1900, became inadequate to handle the increased tonnage from the mine, even though it had been remodeled and its flowsheet revised in 1906, by Gelasio Caetani, then mill superintendent. The North mill, built in 1907 to re-treat tailings from the dump of the old South mill operations, was used as an auxiliary unit to the South mill until November 9, 1909, when the new West mill No. 1 was placed in operation, with increased tonnage facilities and improved equipment. On April 17, 1912, a second unit of the West mill was placed in operation. This unit was built under the supervision of R. S. Handy, who succeeded Mr. Caetani as mill superintendent on January 1, 1910. The South mill, which had discontinued treatment of Bunker Hill ore upon completion of the West mill, burned in 1920, and was rebuilt in 1925, for the purpose of treating the ore from the Star mine, of the Sullivan Mining Co.

On May 25, 1917, the Bunker Hill & Sullivan M. & C. Co. joined with the Hecla Mining Co. in forming the Sullivan Mining Co., and this latter company purchased the Star mine at Mullan, adjoining the Morning mine of the Federal Mining & Smelting Co. The ore from this mine has a relatively high zinc content, and because there was no plant in the district to treat the mill concentrates of the zinc sulphides, construction of an electrolytic zinc plant was decided upon by the Sullivan Mining Co. Construction began in 1926, the location of the plant being in Government Gulch, about four miles west of Kellogg. The plant was completed and put into operation in August, 1928. The operation continued uninterrupted until May 1, 1930, when the low price of metals and the decreased demand for slab zinc made curtailment to one-fourth capacity advisable.

In the spring of 1920, the Bunker Hill & Sullivan M. & C. Co. acquired a 50 percent interest in the Northwest Lead Company, located at Seattle, Wash. This company manufactures lead plumbing supplies, white lead and other commodities, and furnishes an outlet for a portion of the lead produced at the Bunker Hill smelter.

This somewhat brief historical outline gives the high lights of the development of the Bunker Hill & Sullivan Mining & Concentrating Co. from the date of discovery down to the present time. Following articles will describe in more detail the operation of the several departments.

GEOLOGY

THE Wardner section of the Coeur d'Alene district, in which is situated the Bunker Hill Mine, is a rough, mountainous area, traversed by the south fork of the Coeur d'Alene River, which forms a valley about three-fourths of a mile wide, in which the town of Kellogg is located. The elevation of the valley is about 2,250 feet above sea level, and the surrounding mountains rise steeply, reaching a maximum elevation of 6,300 ft. The elevation of the outcrop of the Bunker Hill lode is approximately 3,800 ft.

The geology of the district, as well as of the Bunker Hill mine, has been extensively studied, and several papers have been published, covering in detail all the features of interest, and the reader is referred to these papers* for a comprehensive study of the subject. A brief summary of the important features will be given here.

Sedimentaries belonging to the Belt group of the Algonkian system, pre-Cambrian age, comprise the principal country rock of the district, and these have been classified and are known stratigraphically throughout the district as Pritchard, Burke, Revette, St. Regis, Newland (Wallace) and Striped Peak.

The Pritchard formation, the lowest in the series, has a thickness of about 8,000 ft., and consists of dark gray shale and slate, with some quartzites embedded near the top.

The Burke has a thickness of about 3,500 ft., and consists of pale tinted, silicious shale and sericitic quartzite.

The Revette has a thickness of 2,300 ft., and has the same composition as the Burke, but more massive and silicious.

The St. Regis has a thickness of about 1,000 ft., and consists of quartzite, sandstone and shale, of purple to green coloring.

The Newland, or Wallace, has a thickness of 4,000 ft., and consists of thin bedded, calcareous shale, grading indistinctly into St. Regis.

The Striped Peak formation, where exposed, has a thickness of about 1,000 ft., and resembles the St. Regis in its composition of lilac colored quartzite beds.

The orebodies of the Bunker Hill mine are found in the Burke and Revette quartzites in severely faulted areas. The irregular area in which orebodies occur is composed of a brecciated mass of quartzite, about 1,000 ft. wide and 6,000 ft. long, bounded by three major faults known locally as the Sullivan, Buckeye and Iron Hill. The general strike of this brecciated area is N. 45 deg. W. and dips about 40 deg. S. W. In this area occur the orebodies, usually having a strike diagonal to that of the bedding planes of the quartzites. The average dip of the orebodies is about 40 deg. S. W. The orebodies are also closely associated with two other major faults, the Upper and Lower Cate. The former is regarded as being pre-mineral, while the latter is classed as post-mineral. The ore occurrences may be broadly divided into two types, the Bunker Hill and the Jersey. The former consists of wide, irregular masses of galena with siderite and quartz gangue. There is generally one well defined wall, but never two. The dip is between 40 and 50 deg. About 80 percent of the production of the mine has come from this type of vein. Veins of the Jersey fissure type vary in width from a few inches up to 40 ft., and have a dip of 45 to 50 deg. They carry some siderite, but the principal gangue is quartz, and they are found traversing hard quartzite.

The ore minerals are principally argentiferous galena, with a small percentage of associated zinc minerals.

* U. S. G. S. Professional Paper No. 62, "The Geology and Ore Deposits of the Couer d'Alene District, Idaho," by Ransome and Calkins, 1908.
U. S. G. S. Bulletin No. 782, "Geology and Ore Deposits of Shoshone County, Idaho," by Umpbleby and Jones.
Mining & Scientific Press, "Genesis of the Silver-Lead Ores in the Wardner District, Idaho," by Oscar H. Hershey.

MINING METHODS at the Bunker Hill

By
J. W. Gwinn
and
U. E. Brown*

THE MINING OPERATIONS are conducted through the Kellogg tunnel or No. 9 level, having a length of 10,000 ft. from the portal to the shaft. The No. 1 shaft, inclined at an angle of 50 degrees, gives access to the workings on the lower levels, Nos. 10 to 19, inclusive, and through this shaft all ore from these levels is hoisted. Parallel to this shaft and 460 ft. farther along the tunnel is the No. 2 shaft, inclined at an angle of 40 deg. 35 min., which is used to service the lower levels with tools, timbers, and other supplies, as well as furnish transportation for part of the mine crew. About half way between these shafts the tunnel is conected with the upper workings of the mine and with the Reed tunnel, by the Dull raise, having an inclination of 51 degrees.

The No. 1 shaft contains three compartments, two for hoisting, each 5 ft. x 5 ft. 6 in. in size, and the third 5 ft. 6 in. x 5 ft. 6 in., for manway and pipe lines. In sinking this shaft, three miners drill the round (*Figure 1*) on night shift, using jackhammer type drills equipped with 1-in. hexagon steel. A crew of seven men shovel and hoist the muck on day shift, and two timbermen put in the set (*Figure 2*) as soon as the shovelers have finished, and the bottom has been advanced the proper distance. Each set of timbers is set on line and grade by one of the engineers, using a transit. The average rate of advance per day is 2.27 ft. For hoisting the muck, a small service hoist is temporarily set up on the station floor above the work, and a short raise is run from a side drift at the station to a point under the shaft about 40 ft. above the level, to serve as a storage chute for each round of muck, until such time as the main hoist and skip are available for hoisting it to the top, where it is distributed for stope filling. Each segment of the shaft is sunk 90 ft. below the level of the new station, and at a point 75 ft. below the station floor a 55-deg. inclined raise is run on the same course as the shaft, to a point on the new level 90 ft. from the station. This raise is timbered with 10-in. x 10-in. posts 7 ft. long, and 10-in. x 12-in. caps and sills, and is divided into two compartments and lined with 3-in. plank. This raise then becomes the pocket for ore and waste to be hoisted from the level.

The station is cut on the same course as the shaft, and is extended 185 ft. from the shaft, the first 50 ft. being made 20 ft. wide and the balance being narrowed down to 15 ft. in width. From the face of this enlarged crosscut the development drifts for the level are extended, as well as a crosscut to reach the correct position from which to start the new work on the No. 2 shaft, which is run as a raise from each succeeding bottom level, instead of sinking, as is done with No. 1 shaft. At the station near the shaft, a crosscut is run at right angles to the shaft and 8 ft. below the station floor for a distance of about 35 ft., thence turned at right angles and run parallel to the enlarged station crosscut at a distance of 180 ft., until the top breaks into the bottom of the development drift (*Figure 3*). A concrete dam is then placed in the right-angle turn of the sump drift, making a sump out of the long section, to catch any water that may be developed on the level, whence it is pumped to the top.

The cost of shaft sinking for the last lift that was sunk in 1926, exclusive of the station and the ore pocket raise, was as follows:

	Per ft.
Sinking crew labor	$30.14
All other labor	5.64
Timber and supplies	15.43
Power	2.21
New equipment	4.19
Total	$57.61

The No. 2 shaft, or White raise, is made by raising from each new level to the next level above. It contains three compartments, two for hoisting and one for manway and pipe lines. The size of the two hoisting compartments is 4 ft. 7 in. wide by 5 ft. high, and of the manway 3 ft. 2 in. by 5 ft. There are two drillers in the face, using self-rotating stoper drills. They drill and blast two rounds, making room for two sets of timber, and on the third day timbermen place two sets on line and grade furnished by the engineer. The average rate of advance is 5 ft. per day. For hoisting timbers and steel to the face a small air hoist is located on the station level at the bottom. The inclination of the shaft is 40 deg. 35 min. Timbering used is the same as in the No. 1 shaft, except that the caps and sills are shorter, because the raise is narrower than the shaft. The method of framing the timbers is the same as in the shaft. Following are the costs of the last raise, run in 1927:

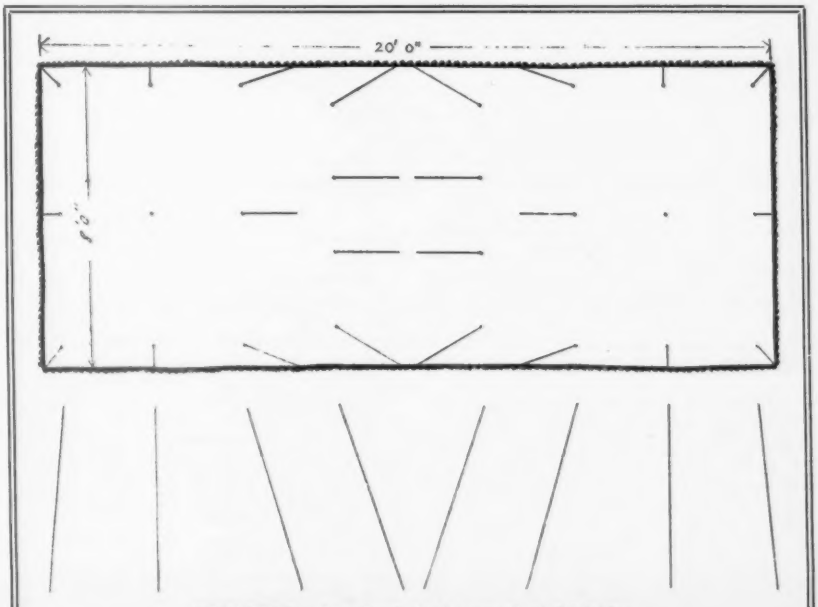


FIGURE 1—*Standard shaft round of 26 holes*

* Chief Engineer, Bunker Hill & Sullivan Mining & Concentrating Co.

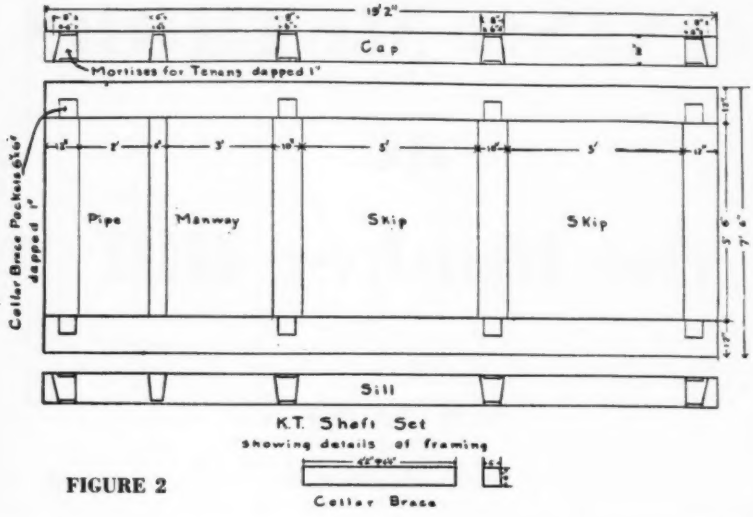


FIGURE 2

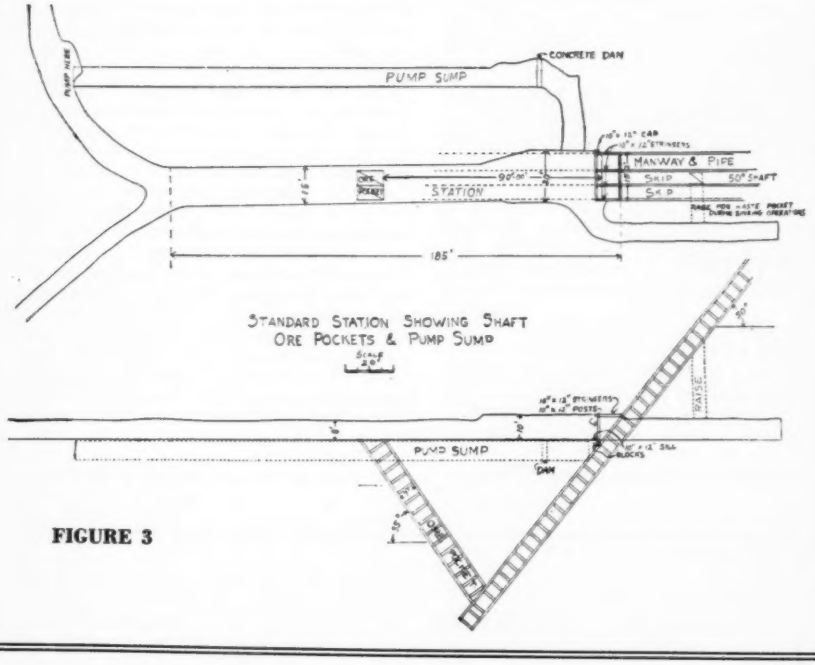


FIGURE 3

	Per ft.
Raising crew labor	$9.59
All other labor	.99
Timber and supplies	5.90
Power	1.44
Total cost	$17.92

Drifts and crosscuts are drilled and blasted on day shift and mucked out on night shift. Unless the ground is very hard, one man does the drilling, using Leyner type of drifting drills, equipped with 1¼-in. round hollow steel. If the ground is too hard, two machines are used in the face. The average standard size of timbered drifts is 7 ft. by 6 ft., inside the timbers. Of untimbered drifts, about 8 ft. by 8 ft. The cost of 6,057 ft. of development work done during 1930 was $11.369 per foot. Subdivisions of these costs are shown elsewhere in this article.

Of the two types of veins stoped in the mine, the Jersey type is the easier and cheaper to work. This fissure vein, having a dip of 45 to 50 degrees, varies from a few inches in width to 40 ft., and has a somewhat higher metallic content than the Bunker Hill vein. The distinguishing feature of the ore in this vein is the predominance of quartz as a gangue, with relatively small amounts of siderite. The wall rock is usually hard quartzite, which does not often require timbering other than occasional stull and headboard to support the unbroken ore.

Cribbed chutes and manways are carried up with the stope, and waste filling is used to support the roof and provide access to the ore in the backs. The ore is drilled and blasted down on plank flooring temporarily laid over the waste filling and shoveled into a near-by chute, after the coarse waste is sorted out. If insufficient waste for filling is obtained from the broken ore, additional waste is brought into the stope through raises to the next level above, and distributed by means of a small scoop car on temporary 16-lb. rails laid on the waste filling.

Generally the waste raise is placed near the center of the stope, and the stope backs then carried higher at this point than at the extreme ends, which permits part of the waste filling to be distributed by gravity. Chutes are 36 in. by 36 in. inside measurement, and are spaced 15 to 20 ft. apart. Manways are 36 in. by 48 in. and spaced 50 ft. apart. Cribbing used is 10-in. half-round with the flat side inward on chutes and the round side inward on manways to afford better footing. If the stopes become very wide, or soft ground is encountered, square sets may be used in that portion of the stope. When the stope reaches a height that is about 24 ft. below the next level above, square sets are placed on the rock fill and tightly filled with waste, and the balance of the stope is then carried up with square sets, to prevent loss of the level above.

The Bunker Hill type of vein occurs as a wide, irregular mass of galena, siderite, and quartz, with siderite predominating as the gangue. Generally there is one, but never two, well-defined walls, and irregular stringers of ore may extend into the country rock on both sides. All the ore is taken, and even though some may be quite low grade, the mining of this low grade often leads to bodies of much better grade. The ore bodies vary in length from 300 to 1,000 ft. and from 30 to 125 ft. in width, severely brecciated and interlaced with numerous small faults and slips, which extend into the overlying country rock, herein known as the hanging wall, even though there is no well-defined wall. This hanging-wall area is very heavy and can not be held by timbers alone after ore is removed. However, a combination of timbers with closely packed waste filling, and the method of mining in use, has proven very effective.

The present system of stoping and timbering these wide areas has been in use about 15 years and was developed by William McDougall, mine superintendent. This system is known locally as vertical slicing, and consists essentially of initial mining being done against the hanging-wall side, carrying the square sets up, and at the same time extending them toward the footwall, but only fast enough to keep a vertical face of ore from the highest point in the stope downward. By this method the footwall supports the entire weight of the unbroken ore, and the tightly filled sets support the weight of the heavy hanging-wall country. Other advantages of this system over the old system of flat-back stoping are the increased safety to the workmen from falling rock, more accessable for drilling "uppers," less mucking of broken ore required, due to ease of placing plank slides to the chutes, better ventilation, and the almost complete elimination of stope caving.

In starting a stope using this system, a drift is run on the footwall of the ore to its extremities, and if the ore is wider than the drift, crosscuts are driven to the limits of the ore on the hanging-wall side. This outlines the extent of

FIGURE 5

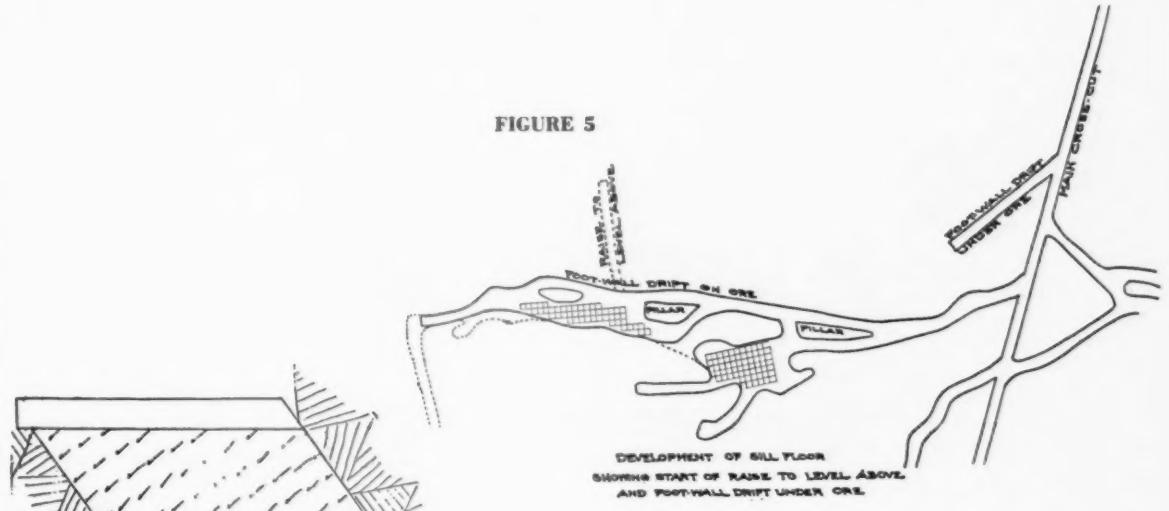


FIGURE 6—*Stope started on hanging wall and beginning of foot wall raise*

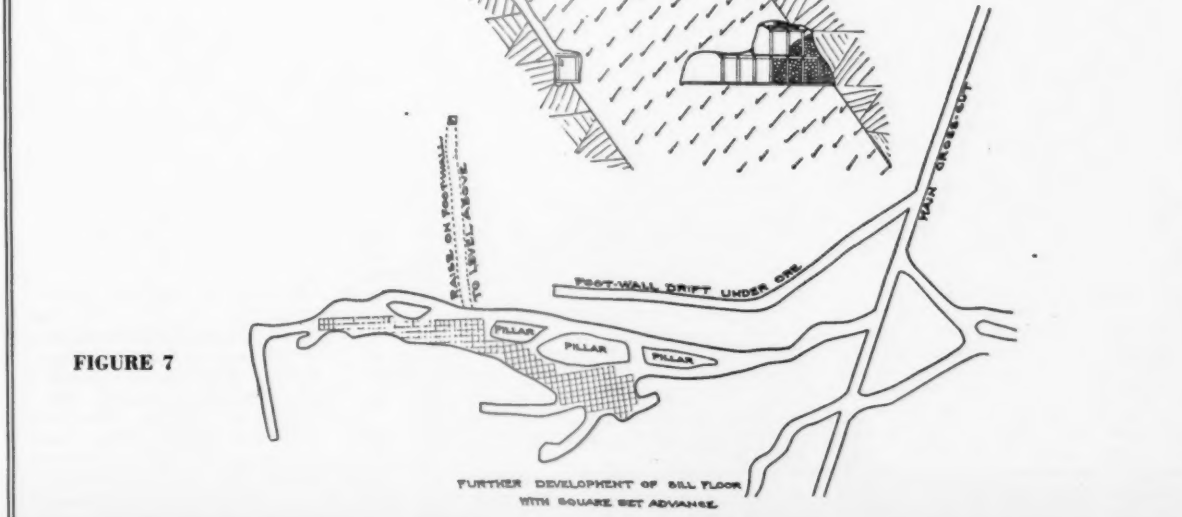


FIGURE 7

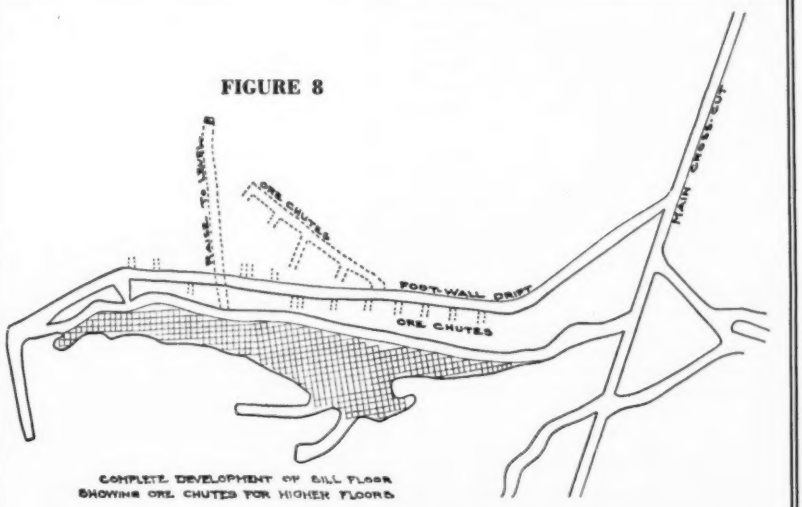
the orebody roughtly. Stoping is then commenced on the hanging-wall side as outlined above and shown in *Figure 5*. From the footwall drift, at about the center of the ore shoot, a raise is driven in the footwall to the next level above. When completed, it is timbered into three compartments, using 6-ft. posts and 10-ft. caps. One side is used for a waste pass, one for a timber pass, and the center is used as a manway and for air and water pipes. When the peak or arch of the stope previously started on the hanging-wall side is from four to six floors high, a crosscut is run from the footwall raise to connect with the top of the stope at that height. Chute gates are put in the waste compartment, temporary track is laid, using 16-lb. rails, in the crosscut and along the top floor of the stope toward each end to provide facilities for distribution of waste filling by means of scoop cars. The timbering in the crosscut is raised as the elevation of the stope increases, so that the filling is always available on the top floor.

After a stope is well started, a drift is run 20 or 30 ft. in the footwall of the ore and parallel to it, to provide permanent haulageways from the stopes, free from the usual troubles of broken and crushed timbers when the haulageway is left under the stope in the sill floor timbers. From this footwall drift, raises are run about parallel to the footwall, intersecting the vein near the level above. From these raises branches are run into the stope, and if necessary these are in turn branched, which system provides excellent chutes for the entire life of the stope, because their location in the footwall keeps them free from any stope pressures and weight. The footwall raise is not timbered, but the branches to the stopes are generally cribbed, at least that part of their length that projects into the stope. This system of chutes, by the steep angle of inclination, and absence of timbers, eliminates "hanging up" of the ore, and thus speeds up the tramming operation.

One of the chief requisites of this system of stoping is a plentiful supply of available waste for filling. This is secured from development work, shaft sinking, and where necessary by driving waste raises in soft ground away from the stoping area, where natural caving supplies the material. To handle this waste and have a supply available at all times, a series of raises have been run from No. 17 level to No. 9 level, from which filling may be drawn or dumped into at any of the intermediate levels. For further description of this system, the reader is referred to Information Circular 6407, "Mining Methods of the Bunker Hill and Sullivan Mining and Concentrating Company," by U. E. Brown, published by the U. S. Bureau of Mines.

Ore haulage on the levels below the Kellogg tunnel, from the stopes to the skip pockets, is done by means of storage-battery locomotives and Bunker Hill type cars having a capacity of 2 tons each. The locomotives range in size from 2½ to 4½ tons capacity, and there are now in use three Jeffrey, six General Electric, and three Westinghouse storage-battery locomotives. On one of these an Ironclad Exide lead battery is used, and on the remainder are used Edison batteries. The motors are serviced and the batteries charged on the levels where they are in use. Two charging generators, capacities of 75 and 40 kw., are located on the 15th and 16th levels as central distribution points and the charging current carried to each of the other levels through cables.

FIGURE 8



Ore haulage from the mine to the mill through the Kellogg tunnel is done by 9-ton trolley type locomotives and Bunker Hill cars having a capacity of 3 tons each. Yard supply trains use trolley type locomotives, varying in capacity from 2½ to 4½ tons. Trolley motors now in use are three Jeffrey and 11 General Electric. Trolley current used is 500 volt d. c.

Hand operated block signals consisting of red and green lights are installed in the tunnel from the portal to the shaft and are operated by the motormen. The 60-lb. rails used in the tunnel are welded at the joints, to provide bonding for the trolley system and to decrease vibration and help to eliminate surface corrugations. Since this method of bonding has been in use, rails do not become severely corrugated for about three years, as compared to three to five months under the old system.

Hoisting of ore is done entirely in the No. 1 shaft, using a 5-ton skip, traveling on 60-lb. rails. The hoist was made in the district by the Coeur d'Alene Hardware & Foundry Co., and is known as the Coeur d'Alene Heavy Duty Double Drum Electric Hoist. Normal rope pull is 22,500 lbs., and the rope speed is 1,050 ft. per minute. It is an 800-hp. single reduction hoist equipped with gravity applied, oil pressure released, parallel motion post brakes, and with oil pressure operated multiple-disc clutches. It is provided with Welch safety controllers combined with dial indicators and is two-thirds fitted with ball bearings. The rope is 1⅛-in. lang lay round steel cable. Power is furnished by two 300-hp. G. E. slip ring motors, 2,200 volts, 3-phase, 60-cycle. One feature of the control is the applied D. C. current to stator of the induction motor during deceleration for dynamic braking.

No. 2 shaft is used as a service shaft for men and supplies. The hoist used in this shaft is an electrically operated hoist, also built by the Coeur d'Alene Hardware & Foundry Co., and is designed especially for lowering duty. It is powered with a 135-hp. slip ring G. E. motor, and is equipped with two power-operated and two hand-operated band brakes, electro-dynamic auxiliary braking apparatus, hand-operated multiple disc clutches, ball bearings throughout, and safety controllers with dial indicators. The rope used is ⅞-in. lang lay steel cable.

Water from the lower levels in the shaft is pumped to the No. 9 level and flows by gravity to the outside. About 700 gals. per minute is pumped, but the pumping is done in two lifts. On the 13th and 17th levels there are two pumps each, No. 4 Cameron Turbine Centrifugal, Class "HMT," 6-stage, with capacity of 550 gals. per minute each, under a head of 860 ft. These are equipped with motors of 200-hp., 1,750 r. p. m., 2,200-volt, 3-phase, 60-cycle, and are provided with an automatic shut-down. Auxiliary pumps are located on levels 14, 15, 18, and 19. These are Cameron Centrifugal No. 4 "MT," 4-stage, 400 gals. per minute, 400-ft. head and are powered by 75-hp. motors, 2,200 volts. The pump on No. 14 level is full automatic, and the one on No. 19 level is automatic shut-down. On No. 13 level there is an Aldrich plunger pump, 500 to 600 gals. per minute, which is kept as a reserve unit.

Water columns are 8 in. in diameter from No. 13 level to the top of the shaft, and 5 in. below No. 13 level.

Ventilation of the shaft levels and stopes is accomplished by a system of fans and controlled air currents, through air drifts and raises and doors in the main working levels. Four fans are installed at different locations in the mine, two being for suction and two for exhaust. These four fans are American Sirocco fans, Nos. 12, 10 and 9, having capacities of 60,000, 45,000 and 35,000 cu. ft. of air per minute. Motors are 75-hp., 50-hp., 40-hp. and 75-hp., the latter being a synchronous motor.

Compressed air for the mine is furnished from the central power plant in charge of George Mackenzie. The equipment consists of two Bury duplex air compressors, each having a displacement of 3,500 cu. ft. per minute, and each direct connected to an Electric Machinery Co. synchronous motor, 650 hp., 2,200

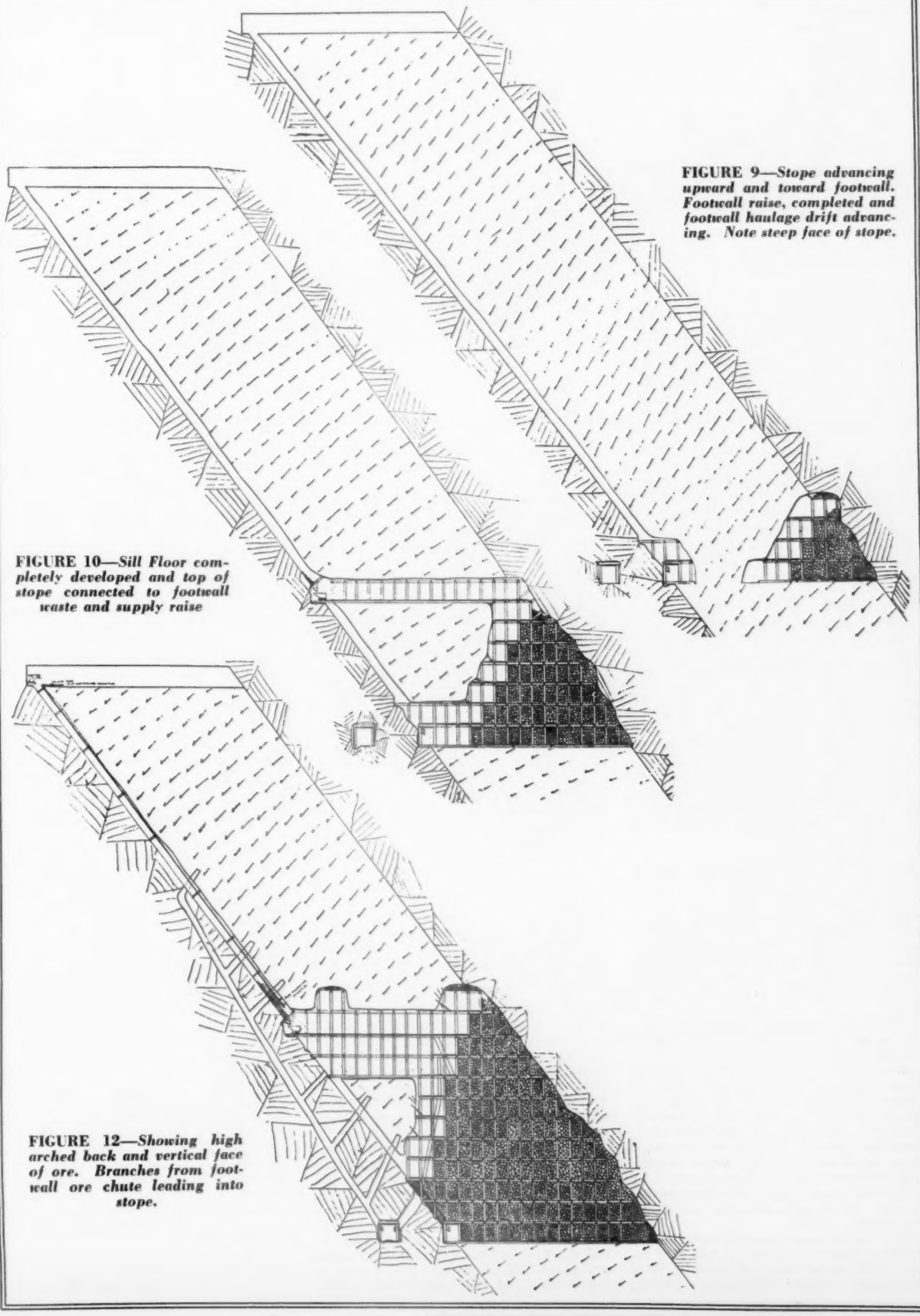


FIGURE 9—*Stope advancing upward and toward footwall. Footwall raise, completed and footwall haulage drift advancing. Note steep face of stope.*

FIGURE 10—*Sill Floor completely developed and top of stope connected to footwall waste and supply raise*

FIGURE 12—*Showing high arched back and vertical face of ore. Branches from footwall ore chute leading into stope.*

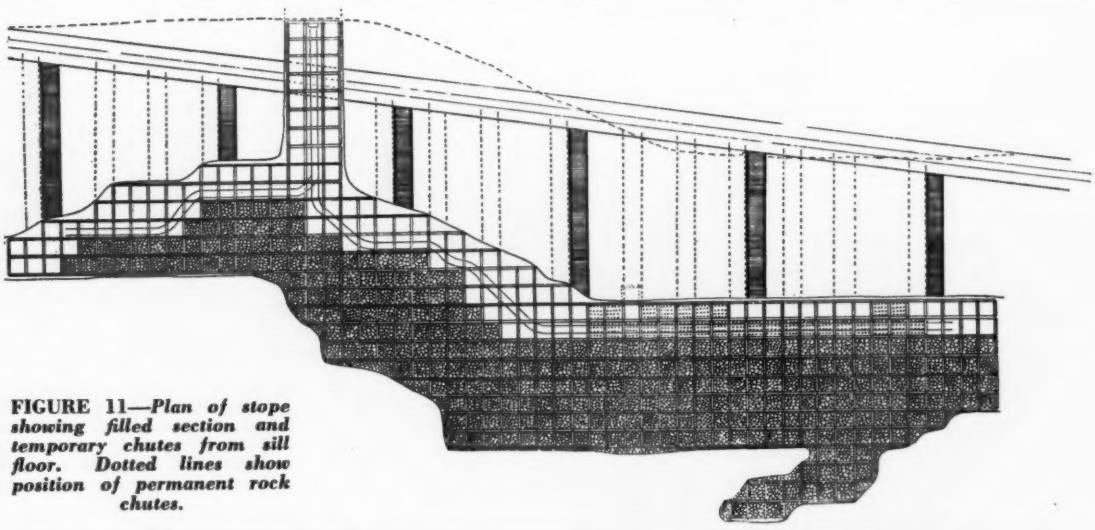


FIGURE 11—*Plan of stope showing filled section and temporary chutes from sill floor. Dotted lines show position of permanent rock chutes.*

volts, 180 r. p. m. There is also one Nordberg compressor, converted from steam to electric drive, having a displacement of 2,000 cu. ft. per minute at 42 r. p. m., rope driven by a G. E. induction motor of 300 hp. There is also one Ingersoll Rand, Class P, duplex machine, 2,200 cu. ft. per minute displacement at 120 r. p. m. driven by a G. E. 400-hp. motor.

Two steam turbine generator units are held in reserve in case of electric power failure. One is a Westinghouse Parsons, reactionary type, 3,600 r. p. m. turbine, driving a Westinghouse alternating current generator, 1,000 kw., 2,200 volts, 252 amp. per terminal. The other is a General Electric Curtis steam turbine, impulse type, 500 kw., 1,800 r. p. m.

For general plant heating and to provide reserve steam to operate the steam turbine units in emergencies, there are four Heine water tube boilers of 250 hp. each. Most of the fuel for the boilers is refuse material from the company's sawmill.

To supply the 500-volt d. c. trolley current, two d. c. motor generator sets are installed. One is a General Electric continuous current generator, type DMC, class 6, form A, 363 amp., 720 r. p. m., 500 volts, driven by a G. E. synchronous motor, 288 hp., 2,200 volts, 57.5 amp. The other is a Westinghouse d. c. generator, 625 r. p. m., driven by G. E. induction motor, 150 hp., 2,200 volts, 40 amp.

There are 10 switch panels, on which are mounted 20 switches, controlling the electrical output to the several departments of the mine, mills, and surface plant, exclusive of the smelter and zinc plant. These switches are electrically operated by current supplied by storage batteries. Each switch also has its individual kilowatt meter and ammeter, from which the monthly power charges are calculated for each department.

An overhead crane of 50,000 pounds capacity facilitates handling of heavy equipment.

The company maintains a fully equipped machine shop, for the mine and mill repair work, under the supervision of Fred P. Porter, master mechanic. Lathes, drill presses, and welding equipment, both electrical and acetylene, and other equipment common to machine shops make it possible and economical to make all repairs, as well as to build mine cars and some other equipment used in the plant. The company has no foundry, and does not make castings.

The tool shop, in charge of Joe Glasson, makes up all steel and picks used in the mine, and keeps the dull steel and picks sharpened daily. About 800 pieces of dull steel come to the shop daily, and about 200 picks. Steel is sharpened on two Waugh sharpeners, and the steel is sharpened and tempered in two DFC oil forges. Steel is taken in and out of the mine in steel buckets loaded on trucks, and are handled in the mine, at the shaft and on the several levels, by air hoists on crawls and chain blocks mounted on crawls.

Stull timber is bought largely from local contractors in the district, and delivered to the company yards, where it is sawed into mine timbers and lagging in the company sawmill. Tamarack and red fir are the only species used in the mine.

Supplies of all kinds are purchased through the company warehouse upon requisition of the various departments, and stored until needed, when they are distributed to the various departments upon written requisition from the department heads.

Power is purchased from the Washington Water Power Co., of Spokane, 80 miles distant, who transmit the current to the Coeur d'Alene district over three 110,000-volt transmission lines. As additional insurance against power interruptions, these lines are tied into a 110,000-volt line from the Thompson Falls plant of the Montana Power Company. Power used by the Bunker Hill & Sullivan Co. is distributed through three substations. At the mine, the transformers consist of two banks of three transformers each, rated as follows: Three 3,333 KVA each, 110,000 volts to 2,300 volts, and three 3,333 KVA each, 110,000 volts to 13,000 volts. At the lead smelter are three 367 KVA each, 13,000 volts to 2,300 volts, and three 333 KVA each, 13,000 volts to 2,300 volts. At the Sullivan Zinc plant, three 3,333 KVA each, 110,000 volts to 2,300 volts. The total power purchased through these substations for the year 1930 was 90,917,970 kwh., which represents an average connected load of 14,105 hp. purchased.

The distribution of power throughout the mine, mills and smelter, and the city of Kellogg, as well as all electrical installation and maintenance in these departments is under the supervision of W. C. Clark, electrical engineer, and his assistant, M. J. Bottinelli.

The following table gives the cost of mining for the year 1930, based on 455,475 tons.

	Cost per ton
Superintendent and foremen	.031
Shift bosses	.066
Machine men	.292
Miners	.325
Shovelers	.677
Carmen and trammers	.075
Motormen	.063
Timbermen and carpenters	.364
Hoistmen and skipmen	.043
Pumpmen	.022
Trainmen	.036
Nippers	.018
Supply men	.049
Repairmen	.003
Timekeeper	.014
Powder	.155
Fuse and caps	.032
Illuminants	.011
Timber and lagging	.359
Miscellaneous supplies	.299
Machine shop repairs	.093
Electric repairs	.037
Building repairs	.017
Tool shop	.028
Electric power	.069
Compressed air	.090
Electric light	.010
Heating	.030
Surveying	.033
Train service	.021
Contingent expense	.107
Administrative expense	.237
Free rent, light, and water	.007
Taxes and insurance	.022
Fire protection	.011
Ventilation	.035
Handling waste	.009
Solarium	.005
Total normal cost	$3.795
Litigation and extraordinary	.038
Diamond drilling	.008
Total cost	$3.841

(*Continued on page* 640)

BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY

MILLING PRACTICE at the Bunker Hill & Sullivan

By
J. W. Gwinn
and
R. S. Handy*

SINCE the erection of the first mill at Wardner in 1886, having a capacity of 100 tons per day, the milling practice at the Bunker Hill & Sullivan has gone through the many changes and improvements incident to the industry throughout the country. The principal equipment in the first mill was crushers, Harz jigs and Cornish buddles. Succeeding mills enlarged somewhat on this flowsheet, and added, progressively, Huntington and Chilean mills, vanners, tables, ball mills and flotation. In the transition to present day practices, the object has been not only to improve the equipment for better mechanical performance, but to add such new equipment, often by replacement of the old, as would improve both the recovery and the grade of the product, at lower costs.

Whereas many mills in the district have gone to straight flotation, the West mill treating the Bunker Hill ore still retains gravity methods in combination with flotation. The policy is to remove as much of the values as possible at the earliest possible stage in the operation, keeping in mind the economical grade of the product so removed. The fact that the company owns its own smelter, and the need of the smelter for fluxing material, permits of lower grade product being made and shipped economically.

The ore from the mine, consisting of argentiferous galena in siderite and quartz gangue, accompanied by a small percentage of sphalerite, is fairly easy to crush as indicated by the life of the crushing media, but in fine grinding operations the hardness of the quartzite becomes apparent. The silver occurs principally in the galena, but the high silver ratio in the siderite-pyrite middlings and in the zinc concentrates indicates the presence of a silver mineral independent of the galena. Table I gives the approximate analysis of the Bunker Hill ore:

TABLE I

Silver Ounces	Lead %	Zinc %	Iron %	Insol. %	Sulphur %	Moisture %
4.0	10.9	1.1	17.4	44.9	3.6	2.0

APPROXIMATE MINERALOGICAL ANALYSIS OF ORE
Percent of Mineral

Galena	Sphalerite	Pyrite	Siderite	Quartz
12.6	2.00	3.6	32.6	44.9

Oxidized ores do not occur in the mill feed, because the mining is done below the horizon of oxidation. An unusual and interesting feature of the ore is the remarkable uniformity of mineral content throughout the 44 years of operation. Table II gives the average assays for the periods indicated.

TABLE II

Period	Years	% Lead	Ounces Silver
1886-1908	22	11.28	4.92
1909-1913	5	10.06	3.88
1914-1921	8	10.10	3.92
1922-1930	9	9.89	3.82

The first unit of the present West mill, designed and constructed under the supervision of Gelasio Caetani, was put into operation November 9, 1909. The original flow sheet provided for crushing to pass 300-mm. screening on 10-mm., and jigging the resulting products. The jigs handling the 10-mm. undersize were provided with a classifying compartment for removing the slimes, which were treated on Frue vanners. Jig concentrates were retreated on tables. Jig middlings were reground in Huntington mills and tabled.

In 1912 the second section of this mill was built under the supervision of R. S. Handy, who succeeded Mr. Caetani as mill superintendent in 1910. The flow sheet was modified to provide for more extensive sizings and for stage jigging. Ball mills gradually replaced Huntington mills for fine grinding. Flotation was added in 1915. Fahrenwald classifiers were placed in operation in 1923 for preparing feed for the tables. Fahrenwald flotation machines, now in use, were first adopted in 1925. In 1927 and 1928 coarse jigs were abandoned and the total feed crushed to pass 7 mm. before being treated in the jigs. In 1928 the grinding and flotation treatment of jig and table tailings was instituted, as was differential flotation to recover the small amount of zinc in the mill feed.

Figures 1, 2, 3 and *4* show the flowsheet of earlier mills, and *Figure 5* shows the present flow sheet.

The ore from the mine bin, 1,325 tons per 24 hours, is reduced in the rock house to pass 7 mm. by crushing and screening. This 7-mm. product becomes the feed for the two sections of the gravity system, only one of which is shown in the flowsheet, where by screening, classifying and jigging, a shipping product of jig concentrates is made assaying 41.40 percent lead, 14.50 ounces silver and 2.90 percent zinc, which represents 56.9 percent of the total mill product, carrying 45.5 percent of the lead content of the feed, 40.4 percent of the silver content and 22.9 percent of the zinc content of the original feed.

The overflow products from the primary classifiers, together with the minus 20-mesh material from the trommels ahead of the jigs are further classified in Fahrenwald hindered settling classifiers and the spigot products of the latter become the feed for the Wilfley No. 6 sand tables on which a shipping product is made assaying 66.50 percent lead, 25.50 ounces silver and 1.9 percent zinc, representing 16.5 percent of the mill product tonnage, carrying 21.2 percent of the lead content of the feed, 20.6 percent of the silver content, and 4.4 percent of the zinc content of the original feed. Thus it is seen that by the gravity methods employed 73.4 percent of the total shipping product is produced, representing 66.7 percent of the lead in the original feed, 61.0 percent of the silver and 27.3 percent of the zinc. It should be explained that the product from the tables may be, and often is made much lower grade than indicated in the above paragraph, if and when there is a demand from the smelter for fluxing ore.

The rejected products from the gravity section are treated in the flotation section. Jig and table middlings are reground and classified in closed circuits with ball mills, the overflow from the classifiers becoming the feed for the flotation section. Fahrenwald 10-cell machines are used as roughers in both the lead and zinc sections, followed by Hearing pneumatic cleaners, producing concentrates in the lead section assaying 66.50 percent lead, 29.4 ounces silver and 5.1 percent zinc, representing 23.42 percent of the total mill product, and carrying 30.0 percent of the total lead in the original feed, 33.6 percent of the silver and 18.6 percent of the zinc. The tailings from the lead rougher become the feed for the zinc section rougher, which is followed by Hearing pneumatic cleaners producing a zinc concentrate assaying 2.38 percent lead, 4.4 ounces silver, and 57.4 percent zinc, representing 3.18 per-

* Mill Superintendent, Bunker Hill & Sullivan Mining & Concentrating Company.

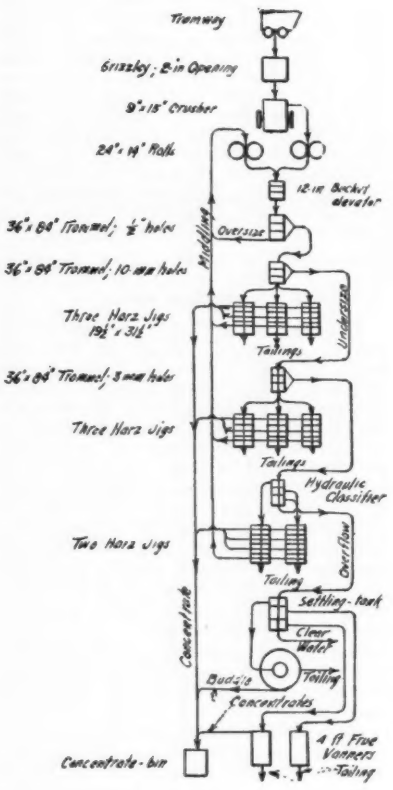


FIGURE 1—*Flow sheet of first mill, 1886*

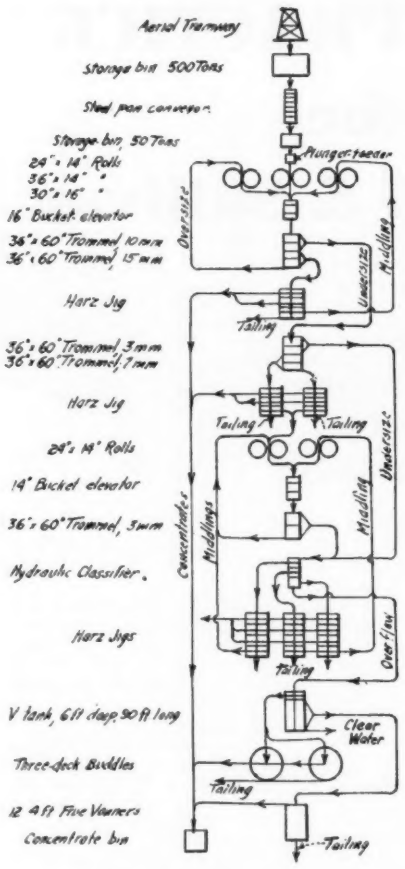


FIGURE 2—*Flow sheet of Old South Mill, 1890*

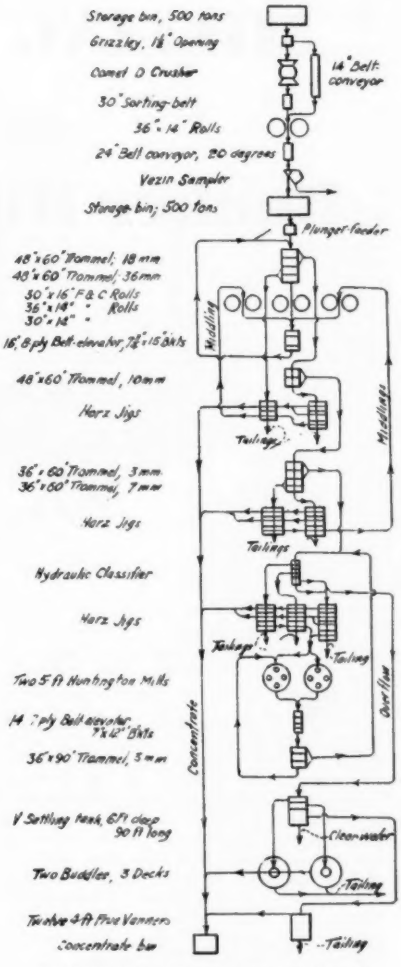


FIGURE 3—*Flow sheet of South Mill, 1906*

Table III. Milling Results. February, 1931

Product	Dry tons	Assay % Pb.	Assay Oz. Ag.	Assay % Zn.	% of total in feed Pb.	% of total in feed Ag.	% of total in feed Zn.
Mill feed	35,414	10.10	4.00	1.40	100.00	100.00	100.00
Jig tails tabled	5,942	.40	.20	.50	.70	.80	6.00
Difference	29,472	12.08	4.70	1.60	99.30	99.20	93.40
Jig Conc.	3,926	41.40	14.50	2.90	45.50	40.40	22.90
Difference	25,546	7.53	3.20	1.40	53.80	58.80	70.50
Middlings	.....	.....	.....	.....	.....	.....	.....
Difference	.....	.....	.....	.....	.....	.....	.....
Table Conc.	1,138	66.50	25.50	1.90	21.20	20.60	4.40
Regrind and slime	24,408	4.78	2.20	1.30	32.60	38.20	66.10
Slime tails	2,754	1.03	.40	.40	.80	.80	2.20
Flotation feed	21,654	5.26	2.40	1.50	31.80	37.40	63.90
Flotation Conc.	1,615	66.50	29.40	5.10	30.0	33.60	18.60
Pb. rougher tails	20,039	.31	.40	1.20	1.80	3.80	45.30
Zinc Conc.	218	2.38	4.40	57.40	.10	.70	25.20
Final tails	19,821	0.29	0.30	0.50	1.70	3.10	20.10
Total Pb. Conc.	6,679	51.76	20.00	3.20	96.70	94.60	43.90

Table IV. Distribution of Milling Costs, cents per ton. February, 1931

	Crushing and Conveying	Screening	Jigging	Grinding	Concentrating	Flotation	Totals
Labor	.029	.016	.055	.023	.025	.028	.176
Supplies	.014	.016	.007	.062	.016	.073	.188
Power	.012	.006	.028	.052	.015	.028	.141
Miscellaneous	.027	.041	.055	.076	.070	.062	.331
Totals	.082	.079	.145	.213	.126	.191	.836

Table V. Reagents and where added

	Pounds per ton of dry ore
Grinding circuit	
2 parts Barretts No. 4, 3 parts cresylic.	.30
Primary slime rougher	
2 parts Barretts No. 4, 3 parts cresylic.	.48
Xanthate	.142
Primary slime middlings	
2 parts Barretts No. 4, 3 parts cresylic.	.27
Rougher middlings, lead	
Xanthate	.035
Cleaners, lead	
Sodium cyanide	.106
Rougher heads, zinc	
Copper sulphate	.25
Soda ash	.06
2 parts Barretts No. 4, 3 parts cresylic.	.06

cent of the total mill product, and carrying 0.1 percent of the total original lead, 0.7 percent of the silver and 25.2 percent of the original zinc. Table III gives the above data in composite form.

The figures in tables III and IV represent the work being done in the West mill at the time this is written. The disagreement between these figures and those for the year 1930 are due to changes which have been made in the mill within the last few months.

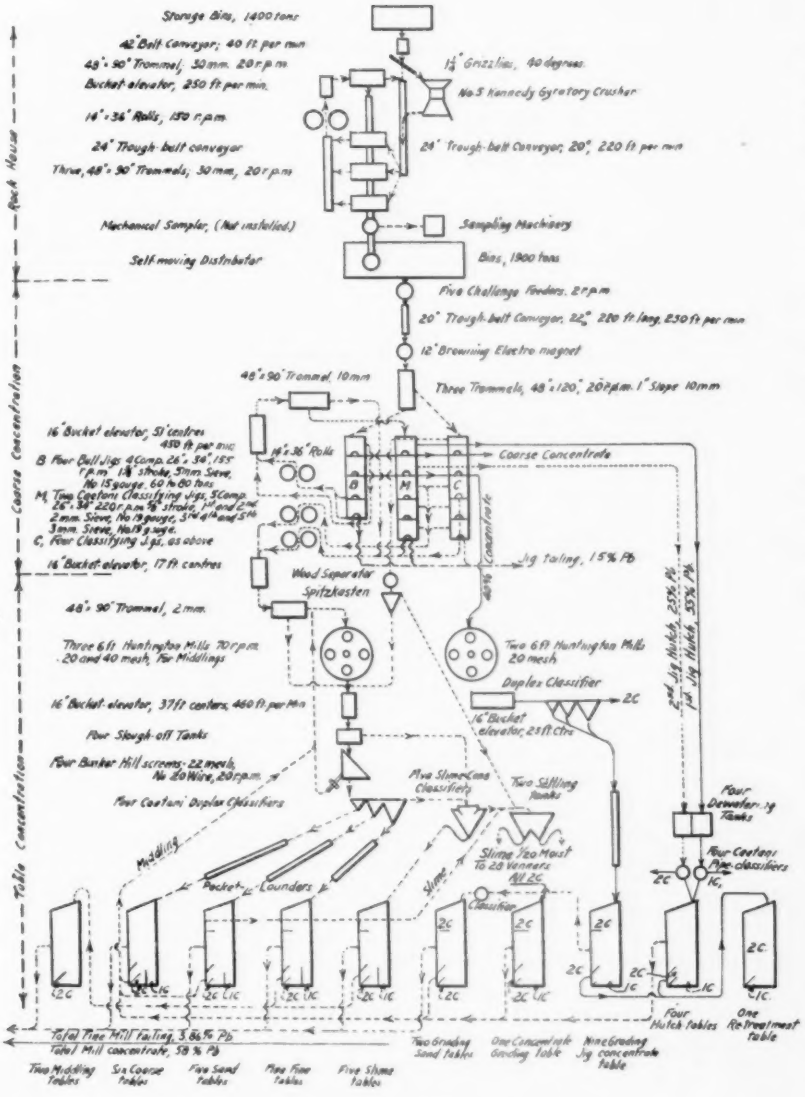

Storage Bins, 1400 tons
42" Belt Conveyor; 40 ft per min
48" x 90" Trommel; 30 mm. 20 r.p.m.
Bucket elevator, 250 ft per min.
14" x 36" Rolls, 150 r.p.m.
24" Trough-belt conveyor
Three, 48" x 90" Trommels; 30 mm, 20 r.p.m
Mechanical Sampler, (Not installed)
Self moving Distributor
1½" Grizzlies, 40 degrees
No 5 Kennedy Gyratory Crusher
24" Trough-belt Conveyor; 20°, 220 ft per min
Sampling Machinery
Bins, 1900 tons
Five Challenge Feeders, 2 r.p.m
20" Trough-belt Conveyor, 22°, 280 ft long, 250 ft per min
12" Browning Electro magnet
48" x 90" Trommel, 10 mm
Three Trommels, 48" x 120", 20 r.p.m. 1" Slope 10 mm
16" Bucket elevator, 51' centres
450 ft per min
B Four Ball Jigs, 4 Comp, 26" x 36", 155 r.p.m. 1¾" stroke, 5 mm Sieve, No 15 gauge, 60 to 80 tons
M, Two Coarse Classifying Jigs, 3 Comp. 26" x 36" 220 r.p.m. ¾" stroke, 1/4" and 2 mm. Sieve, No 19 gauge, 3/4" and 3 mm. Sieve, No 8 gauge.
C, Four Classifying Jigs, as above
16" Bucket elevator, 17 ft centres
16" x 36" Rolls
Coarse Concentrate
Jig Tailing, 15% Pb
Wood Separator
Spitzkasten
48" x 90" Trommel, 2 mm.
Three 6 ft. Huntington Mills 70 r.p.m. 20 and 40 mesh, for Middlings
Two 6 ft Huntington Mills 20 mesh
Duplex Classifier
16" Bucket elevator, 37 ft centers, 460 ft per Min
16" Bucket elevator, 25 ft Ctrs
Four Slough-off Tanks
Four Bunker Hill screens, 22 mesh, No 20 Wire, 20 r.p.m.
Four Coatani Duplex Classifiers
Five Slime Cone Classifiers
Two Settling Tanks
Four Dewatering Tanks
Four Coatani Duplex classifiers
Middling
Pockets
Launders
Slime
Slime Two Must To 28 Venners Mill 2C
Classifier
Four Hutch Tables
One Re-treatment Table
Total Two Mill Tailing, 3.86% Pb
Total Mill concentrate, 58 % Pb
Two Middling Tables
Six Coarse Tables
Five Sand Tables
Five Fine Tables
Five Slime Tables
Two Grinding Sand Tables
One Concentrate Grinding Table
Nine Grinding Jig concentrate Table
Rock House
Coarse Concentration
Table Concentration

FIGURE 4—*Flow sheet of West Mill, 1909*

In the flotation section, one 10-cell machine is run entirely on primary slime-sand overflow from Esperanza classifiers in the gravity section, amounting to 100 tons of dry feed per 24 hours. This overflow contains practically all the primary mine slimes and assays 10.94 percent lead, 5.30 ounces silver and 1.7 percent zinc. The tails from this machine assay .76 percent lead, .41 ounces silver and .34 percent zinc. The classifier overflow from the regrind section, amounting to 800 tons per 24 hours, comprises the feed for the lead section of the differential flotation and assays 5.36 percent lead, 2.6 ounces silver and 1.78 percent zinc, while the tails from this section assay .31 percent lead, .38 ounces silver and 1.2 percent zinc. It will be noted that the capacity of the 10-cell machine on primary sand-slime is only 100 tons per day, while the same machine treating regrind material from which the above slime has been removed, has a capacity of 265 tons per 24 hours. Also the reagent consumption in the slime circuit is about 50 percent higher per ton of ore treated than in the regrind section. The difference in capacity and reagent consumption, together with the decrease of about 60 percent of lead in the tailings from the regrind section, suggests that further experimental work in desliming flotation feed might bring out some very interesting facts relative to increased tonnage, lowered reagent consumption and higher recoveries.

Table V indicates the place of adding flotation reagents, and the quantity used in pounds per ton of dry feed.

Conveyors, elevators and pumps are used to transfer material and make it available for treatment at the various locations in the mill. The general practise is to elevate the material by one of the three methods to a point near the top of the mill, whence it can be distributed by gravity. This permits of great flexibility in changing feeds between the various machines in case of trouble in the circuit. The gravity flow of the products is through launders, which have been standardized as to size and slope for the different products. Table IX gives these launder details.

Figure 5-a shows the wiring diagram and automatic control of the Geary type samplers used in the West mill flotation section. The sampler spout is mounted on a threaded rod which is direct connected to a ¼ hp. reversible motor. This sampler motor circuit is connected to two push buttons, one on each end of the travel of the sampler spout, so that at the end of each trip through the stream to be sampled, the spout trips the switch and automatically reverses the current going to the motor, by use of a reversible magnetic switch and movable contacts in the push button circuit, thus causing the motor to be in readiness to drive the spout in the opposite direction when the predetermined time interval has elapsed. The time interval is determined by the speed of the moving contacts, which consist of two micarta wheels for each sampler, cut to a circle with a small arc of the circumference spirally eccentric. The length of the eccentric arc, and hence the time of contact, is adjusted to the time required for the sampler spout to travel the length of the threaded rod. At each end of travel, the sampler spout operates the push button, reversing the current to the motor, and the return trip is then controlled by the second wheel contact. The drive for the contact wheels is a 1/6-hp. motor connected through gear reducers to the wheels.

One advantage of this method of drive is the remote control feature. Instead of having the electrical mechanism near the sampler, which may often be in a wet location, it may be placed in any convenient location in the mill. Other advantages are the complete automatic features, insuring regular intervals of sampling and uniform time interval for each sample. Another feature of this sampler mechanism is that several samplers can be operated from the same switch and contacts, where it is desired to take samples having the same time interval. In the diagram shown, there are two circuits indicated, because the time interval for sampling, and the amount of sample desired, are different on the feed and the tailings.

The sample is caught in a box having a porous bottom covered with filter cloth and connected to a vacuum, so that it is not necessary to decant the sample and wait a long period for it to dry, but the filtered cake is removed with a spatula, which method insures a better sample, as well as a dry one. The water drawn from the sample is passed through a bottle of clear water, to detect any leakage through the filter cloth of the sampled pulp. A cross section of the sampling and filter arrangement is shown in *Figure 5-b.*

FIGURE 5

FLOW SHEET, WEST MILL

BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY

Ore bin, wood. Capacity, 1,400 tons.

Belt conveyor. Width, 42". Speed, 35-120 ft./min. Capacity, 5,300 tons/24 hrs. Maximum size material, 12".

Grizzley, 4' x 5', 1¼" opening. Slope, 9 in./ft. Capacity, 5,300 tons/24 hrs.

(2) Chalmers & Williams No. 5 Kennedy gyratory crushers. Discharge, 2½". Capacity, 3,975 tons per 24 hrs. Power, 23 hp.

Conveyor belt, 24". Capacity, 5,300 tons/24 hrs. Speed, 318 ft./min. Max. size material, 2½".

(4) Trommels 48" x 90", punched plate. Openings, 1" x 2". Slope, 1 in./ft. 17 & 18 r.p.m. Capacity, 1,750 tons/24 hrs.

Symons Model C vertical disc crusher, 36". Auxiliary, 36" x 14" C. & W. rolls. Capacity, 1,000 tons/24 hrs.

Conveyor belt, 24". Speed, 282 ft./min. Maximum size material, 2". Capacity, 1,000 tons/24 hrs.

Conveyor belt, 24". Speed, 308 ft./min. Maximum size material, 1" x 2". Capacity, 5,300 tons/24 hrs.

Storage bin, wood. Capacity, 1,700 tons.

(10) Chute feeders.

Conveyor belt, 20". Speed, 181 ft./min. Maximum size feed, 1" x 2". Capacity, 1,325 tons per 24 hrs.

Sampler, bucket 3" x 12" x 8" pivoted between two strands of No. 78 sprocket chain.

Trommel, openings, ½".

Dodge crusher, 4" x 6".

Ball Mill, 3' x 36". Belt drive. 15 hp. motor, 29.85 r.p.m. Live feed, 8.21 tons/24 hrs. Total feed, 12.81 tons/24 hrs.

Drag classifier.

Geary sampler.

Feed distributor.

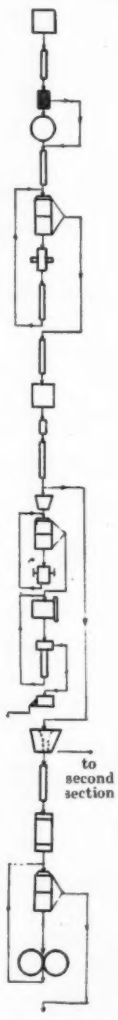
Belt conveyor.

Bucket Elevator, buckets 15" x 7¾" x 8½", maleable cast iron, spaced 16". Speed, 517 ft./min. Maximum size material, ½".

(2) Trommels, 48" x 120", punched plate. 3 plates 7 mm., 1 plate 15 mm. Slope, 1 in./ft. Speed, 17 r.p.m. Capacity, 1,310 tons/24 hrs.

(3) Rolls, 36" x 14". Discharge, 7 mm. Speed, 71 r.p.m. Capacity, 350 tons/24 hrs.

(Continued in next column)



(2) Traylor vibrating screens (1 in use), 69" x 41". 27½ deg. slope. 60 v.p.sec. Opening, 0.130". Capacity, 650 tons/24 hrs.

Belt conveyor, 16". Capacity, 235 tons per 24 hrs.

(3) Harz jigs, 4 comp. 25½" x 33½". Wire mesh sieves, 6 mesh over 3 mesh. Speed, 200 r.p.m. Stroke, 5/8". Capacity, 78 tons per 24 hrs. each.

(2) Wilfley pumps.

Trommell, 24" x 60". 20 mesh opening. Capacity, 415 tons/24 hrs.

(3) Harz jigs, 4 comp. 25½" x 33½". Wire mesh sieves, 8 mesh over 3 mesh. Speed, 240 r.p.m. Stroke, 5/8". Capacity, 63 tons 24 hrs.

Esperanza classifier, 5' x 18'. Blades metal faced wood. Slope, 4 in./ft. Speed, 17 ft./min. Capacity, 225 tons/24 hrs.

Fahrenwald hindered settling classifier. 5 spigots and overflow. Size pockets, 6" x 6". Capacity, 175 tons/24 hrs.

(6) Wilfley sand tables No. 6. Speed, 250 r.p.m. Stroke, 5/8" to 1". Capacity, 17 tons/24 hrs. per table.

Belt drag classifier. Width, 17". Slope, 5 in./ft. Blades, 14" x 4¼", spaced 18". Belt width, 12". Speed, 27¼ ft./min. Capacity, 40 tons/24 hrs.

Oliver continuous sand filter. Size, 12" x 30". Vacuum, 10 in. Pump, Connersville. Moisture in feed, 9.8%. Moisture in product, 6.6%. Capacity, 40 tons/24 hrs.

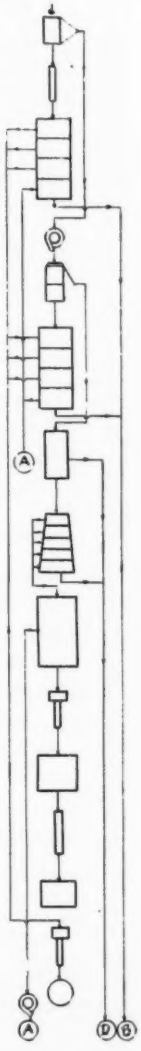
Belt conveyor, 16 in. Slope, 2¾ in./ft. Speed, 101 ft./min. Capacity, 40 tons/24 hrs.

Storage bin, wood. Capacity, 100 tons.

Drag belt classifier, 8". Slope, 5½ in./ft. Belt, 6". Speed, 40 ft./min. Capacity, 75 tons/24 hrs.

Storage bin, steel. Capacity, 170 tons.

Wilfley pump, 3". 1,160 r.p.m. 34' 5" lift. 15 hp. motor.



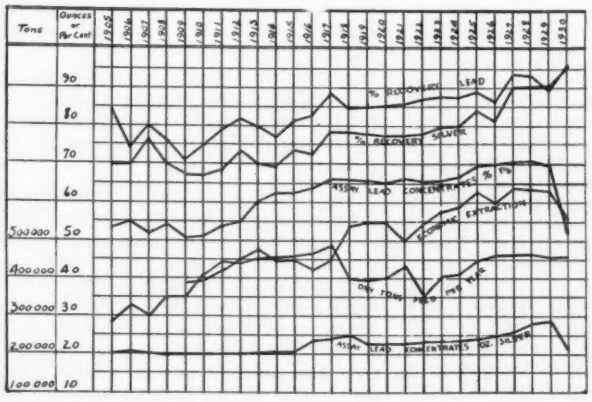


Table XI. Historical Metallurgical Data

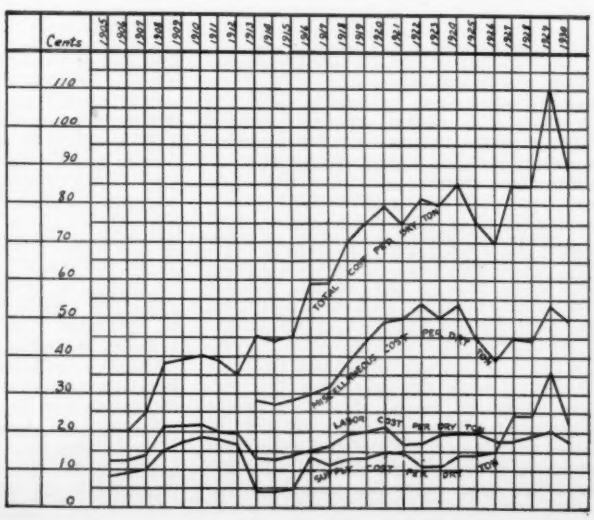


Table XII (right). Graphic Chart of Milling Costs

REGRIND SECTION
High grade mids from jigs and tables

Dorr simplex dewatering classifier. 2' 3" x 14' 8". Speed, 17½ strokes/min.

Hardinge ball mill, 6' x 22". Capacity, 186 tons/24 hrs. 25.6 r.p.m. Belt drive. 3" cast iron balls.

Wilfley pump, 4", 1,160 r.p.m. Motor, 25 hp. direct connected. 160 g.p.m. 36' 7" lift, 1,500 tons/24 hrs. 60.77% solid.

Dorr duplex classifier, 6' Capacity, 186 tons/24 hrs. live feed. Total feed, 1,500 tons/24 hrs. 25 r.p.m. 5 hp. Slope, 3 in./ft.

(2) Hardinge ball mills, 6' x 22". Total feed 625 tons/24 hrs. each. Belt and texrope drive. Speeds, 25.8 and 24.8 r.p.m. 2½" cast iron balls.

REGRIND SECTION
Low grade mids from jigs

Dewatering classifier.

Storage bin, steel. Capacity, 100 tons.

Variable speed belt conveyor feeder.

Belt conveyor, 16". Speed, 60.9 ft./min. Maximum size material, 3 mesh. Capacity, 600 tons/24 hrs.

Hardinge ball mill, 8' x 36". Capacity live feed, 210 tons/24 hrs. Total feed, 972 tons/24 hrs. Drive, double reduction gear. Speed, 18.1 r.p.m. Power, 125 hp. Motor, 150 hp. Size balls, 3" cast iron.

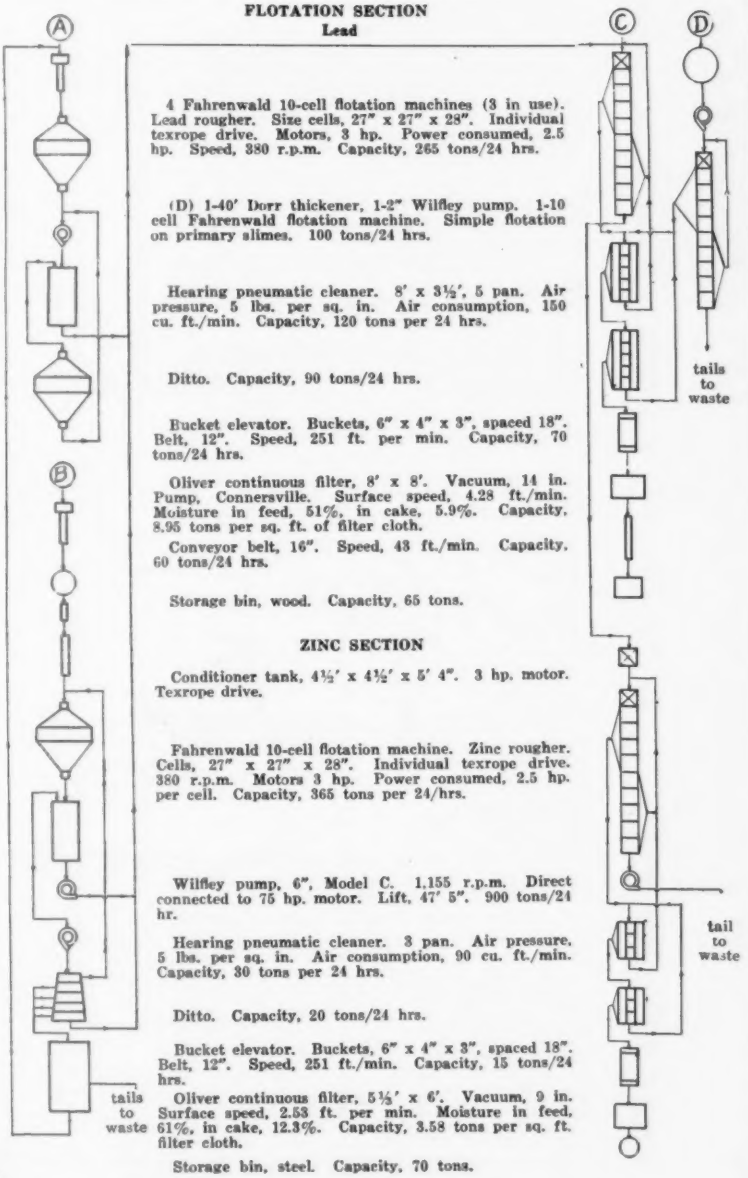
Dorr duplex classifier, 6' x 21' 3". Slope, 3 in./ft. Speed, 24½ r.p.m. Texrope drive. 5 hp.

Wilfley pump, 3", 1,160 r.p.m., 90 g.p.m. 28' lift. 210 tons/24 hrs. 27.8% solids.

Wilfley pump, 3", 1,160 r.p.m., 50 g.p.m. 33¼' lift. 230 tons/24 hrs. 45% solids. 15 hp. direct connected motor.

Fahrenwald hindered settling classifier. 5 spigot and overflow. Size of pockets, 8" x 12" and 8" x 16". Capacity, 230 tons per 24 hrs.

(6) Wilfley sand tables No. 6. Speed, 250 r.p.m. Stroke, 5/8" to 7/8". Capacity, 7 to 30 tons/24 hrs.



FLOTATION SECTION
Lead

4 Fahrenwald 10-cell flotation machines (3 in use). Lead rougher. Size cells, 27" x 27" x 28". Individual texrope drive. Motors, 3 hp. Power consumed, 2.5 hp. Speed, 380 r.p.m. Capacity, 265 tons/24 hrs.

(D) 1-40' Dorr thickener, 1-2" Wilfley pump. 1-10 cell Fahrenwald flotation machine. Simple flotation on primary slimes. 100 tons/24 hrs.

Hearing pneumatic cleaner. 8' x 3½', 5 pan. Air pressure, 5 lbs. per sq. in. Air consumption, 150 cu. ft./min. Capacity, 120 tons per 24 hrs.

Ditto. Capacity, 90 tons/24 hrs.

Bucket elevator. Buckets, 6" x 4" x 3", spaced 18". Belt, 12". Speed, 251 ft. per min. Capacity, 70 tons/24 hrs.

Oliver continuous filter, 8' x 8'. Vacuum, 14 in. Pump, Connersville. Surface speed, 4.28 ft./min. Moisture in feed, 51%, in cake, 5.9%. Capacity, 8.95 tons per sq. ft. of filter cloth.

Conveyor belt, 16". Speed, 43 ft./min. Capacity, 60 tons/24 hrs.

Storage bin, wood. Capacity, 65 tons.

ZINC SECTION

Conditioner tank, 4½' x 4½' x 5' 4". 3 hp. motor. Texrope drive.

Fahrenwald 10-cell flotation machine. Zinc rougher. Cells, 27" x 27" x 28". Individual texrope drive. 380 r.p.m. Motors 3 hp. Power consumed, 2.5 hp. per cell. Capacity, 365 tons per 24/hrs.

Wilfley pump, 6", Model C. 1,155 r.p.m. Direct connected to 75 hp. motor. Lift, 47' 5". 900 tons/24 hr.

Hearing pneumatic cleaner. 3 pan. Air pressure, 5 lbs. per sq. in. Air consumption, 90 cu. ft./min. Capacity, 30 tons per 24 hrs.

Ditto. Capacity, 20 tons/24 hrs.

Bucket elevator. Buckets, 6" x 4" x 3", spaced 18". Belt, 12". Speed, 251 ft./min. Capacity, 15 tons/24 hrs.

Oliver continuous filter, 5⅓' x 6'. Vacuum, 9 in. Surface speed, 2.53 ft. per min. Moisture in feed, 61%, in cake, 12.3%. Capacity, 3.58 tons per sq. ft. filter cloth.

Storage bin, steel. Capacity, 70 tons.

Table XVII. Summary of Monthly Operations at Kellogg, 1930

MONTH	Tons Ore Mined	Tons Ore Trammed	All Mining Costs per Ton Mined	Tons Concentrated	All Concentration Costs Per Ton Mined	Shipping Costs per Ton Mined	All Other Kellogg Costs Per Ton Mined	Total Kellogg Costs Per Ton Mined	Ore Treated to Make One Ton Mill Product	Tons Concentrate Produced	Concentrates Assay: Lead	Silver	Zinc	Prices: Lead	Silver	Zinc	Gross Assay Value	Freight, Treatment and Discounts	Net Kellogg Value	Kellogg Costs of Production	Kellogg Surplus
January	37,409	37,409	4.377	37,409	1.133	.035	.283	5.828	6.16	6,074.29	54.27	22.64	6.95	6.25	44.39	5.19	85 10	31.11	53.99	34 15	19.84
February	35,453	35,453	4.072	35,453	1.113	.030	.300	5.515	6.43	5,511.14	56.97	23.00	6.70	6.20	42.51	5.13	87.33	31.91	55.42	33.54	21.88
March	39,347	39,347	3.838	39,347	1.051	.026	.271	5.186	5.63	6,993.65	52.14	21.02	6.04	5.62	41.99	4.88	73.33	28.99	44.34	27 65	16.69
April	37,188	37,188	3.805	37,188	1.011	.022	.307	5.145	4.95	7,510.33	48.21	19.69	5.76	5.51	42.45	4.76	66.99	24.57	42.42	23.95	18.47
May	39,083	39,083	3.681	39,083	.963	.019	.300	4.963	4.90	8,045.33	50.02	20.56	5.86	5.53	40.00	4.63	68.93	25.39	43.54	22.66	20.88
June	37,741	37,741	3.806	37,741	.885	.025	.494	5.210	5.20	7,258.29	48.66	20.11	6.53	5.38	34.38	4.36	65.00	25.09	39.91	24.52	15.39
July	37,749	37,749	3.696	37,749	.927	.026	.333	4.982	4.65	8,121.87	47.16	18.67	6.15	5.26	34.42	4.52	61.58	24.88	36.70	21.61	15.09
August	37,812	37,812	3.755	37,812	.824	.052	.868	4.989	4.80	7,867.42	47.48	19.20	4.65	5.50	35.30	4.10	62.81	23.90	38.91	22.26	16.65
September	38,761	38,761	3.744	38,761	.755	.028	.326	4.853	4.54	8,533.94	45.28	17.64	4.78	5.49	36.33	4.22	60.16	23.70	36.46	20.56	15.90
October	39,390	39,390	3.923	39,390	.841	.028	.317	5.109	4.82	8,159.82	45.94	18.38	5.12	5.13	35.90	3.91	57.75	23.31	34.44	23.13	11.31
November	38,146	38,146	3.523	38,146	.952	.032	.365	4.872	5.25	7,262.85	50.09	19.90	5.81	5.10	35.78	4.29	63.19	24.75	38.44	23.67	14.77
December	37,396	37,396	3.897	37,396	.897	.030	.551	5.375	5.25	7,128.34	49.87	20.99	5.76	5.09	32.18	4.06	62.21	24.54	37.67	25.31	12.36
Totals and Averages	**455,475**	**455,475**	**3.841**	**455,475**	**.945**	**.030**	**.350**	**5.166**	**5.15**	**88,467.27**	**49.32**	**19.98**	**5.78**	**5.49**	**37.88**	**4.50**	**66.92**	**25.73**	**41.19**	**24.77**	**16 42**

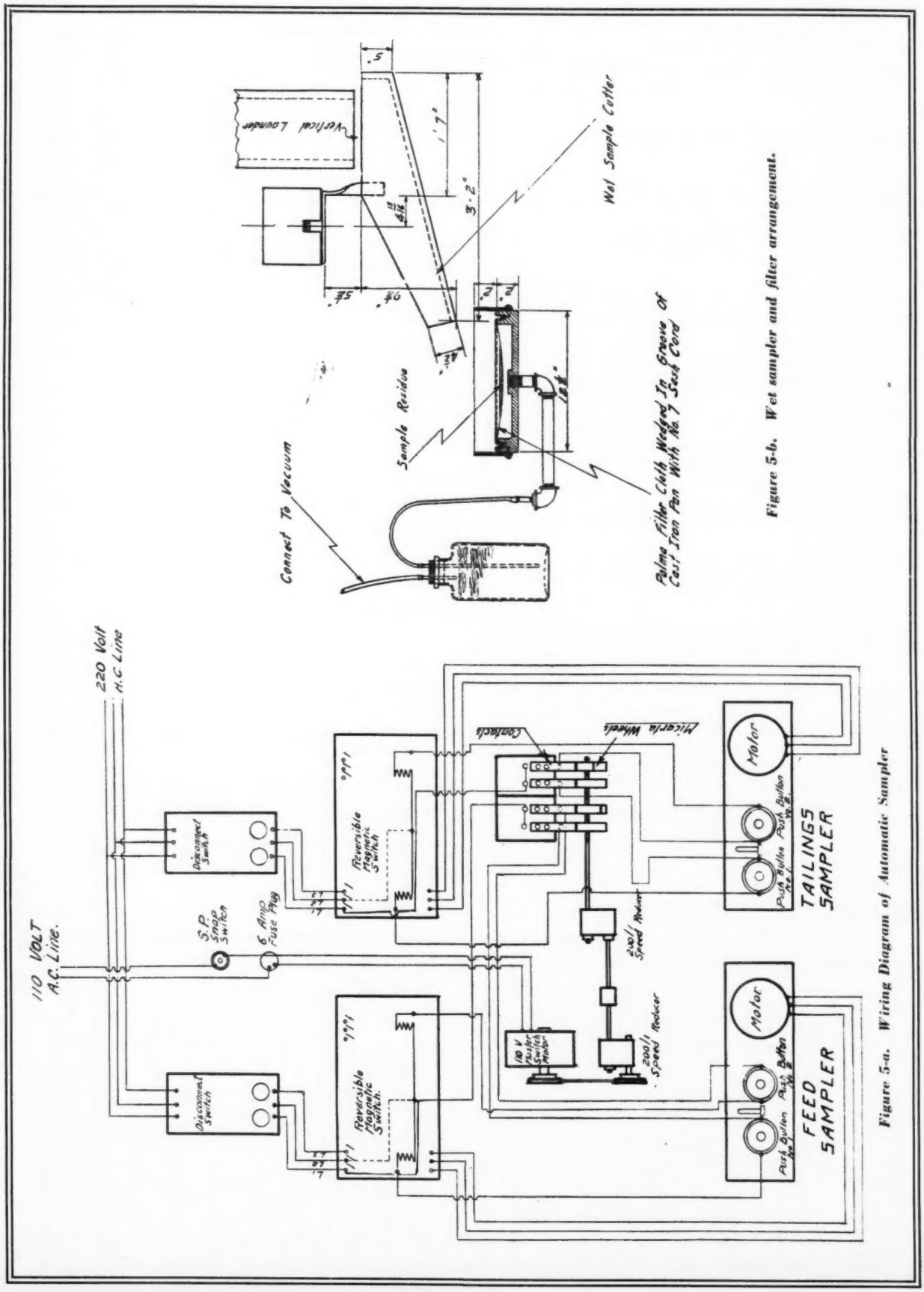


Figure 5-b. Wet sampler and filter arrangement.

Figure 5-a. Wiring Diagram of Automatic Sampler

Table VI. West Mill screen sizes, percent

GRAVITY CONCENTRATOR

Screen size	Mine run	Secondary crushing	Mill feed	Jig feed	Jig concentrates	Jig tailings	Table feed	Table concentrates	Table tailings
On 3-in. ring	6.24	.....	.....	.....	.....	.....	.....	.....	.....
2-in. ring	5.71	13.3	.....	.....	.....	.....	.....	.....	.....
1.050 in.	10.81	60.00	.....	.....	.....	.....	.....	.....	.....
0.742 in.	7.00	22.2	.....	.....	.....	.....	.....	.....	.....
0.525 in.	7.08	4.5	10.07	.....	.....	.....	.....	.....	.....
0.371 in.	9.33	.....	13.29	.....	.....	.....	.....	.....	.....
3 mesh	10.09	.....	14.35	2.9	.4	1.2	.....	.....	.....
4 mesh	8.40	.....	11.98	20.8	11.8	15.6	.....	.....	.....
6 mesh	7.79	.....	11.12	20.8	17.8	29.8	.....	.....	.....
8 mesh	4.54	.....	6.46	14.4	14.6	20.4	.....	.....	.....
10 mesh	4.09	.....	5.82	15.1	8.4	16.0	.....	.....	0.3
14 mesh	3.08	.....	4.38	11.6	10.6	10.4	2.2	.....	3.4
20 mesh	2.16	.....	3.08	8.5	12.2	4.6	8.0	0.5	12.2
28 mesh	1.89	.....	2.68	3.8	11.2	1.4	9.6	6.2	15.6
35 mesh	1.52	.....	2.16	1.2	6.8	0.6	10.2	11.3	13.2
48 mesh	1.24	.....	1.77	0.9	3.6	.....	12.4	13.2	14.6
65 mesh	1.01	.....	1.44	.....	1.4	.....	18.0	17.5	19.0
100 mesh	1.06	.....	1.51	.....	0.8	.....	18.6	17.3	16.0
150 mesh	0.74	.....	1.05	.....	0.4	.....	10.4	11.7	4.4
200 mesh	0.64	.....	0.92	.....	.....	.....	6.6	9.8	1.3
—200 mesh	5.58	.....	7.92	.....	.....	.....	4.0	12.5	.....
	100.00	100.00	100.00	100	100	100	100	100	100

FLOTATION

Screen size	Primary slimes: Feed	Primary slimes: Rougher concentrate	Primary slimes: Tailing	Lead section: Feed	Lead section: Concentrate	Lead section: Tailing	Zinc section: Concentrate	Zinc section: Tailing
On 48 mesh	....	....	....	0.3	....	0.4	....	0.5
65 mesh	....	....	0.2	2.2	....	3.9	....	3.8
100 mesh	0.8	0.5	1.9	8.4	0.3	12.2	0.8	12.2
150 mesh	2.8	0.9	4.8	11.3	2.2	12.4	3.6	12.3
200 mesh	6.6	3.0	8.6	12.2	4.5	13.6	5.7	13.6
—200 mesh	89.8	95.6	84.5	65.6	93.0	57.5	89.9	57.6
	100	100	100	100	100	100	100	100

Table VIII. Grinding Media Data—Hardinge Ball Mills

Size Mill	R. P. M.	Size Feed	Tons 24 hrs.	Type Liner	Service in Months Row Number A	B	C	D	E	F	
8′	20	7 mm.	400	C I	7	8	9	9	9	9	(C)
8′	20	7 mm.	400	Steel	9	11	13	13	13	13	(C)
8′	18	20 mesh	170	C I	11	15	23	19	15	18	(C)
8′	18	20 mesh	170	Steel	11	15	..	18	15	18	(C)
6′	26	20 mesh	650	C I	12	12	16	16	16	..	(C)
6′	26	20 mesh	650	C I	18	18	..	..	..	..	(C)
6′	26	20 mesh	650	Steel	..	..	21	21	21	..	(C)
6′	26	7 mm.	186	Steel	26	26	30	30	30	..	(O)
6′	26	7 mm.	186	Mang.	27	27	31	31	31	..	(O)
6′	26	20 mesh	650	Steel	26	26	29	29	29	..	(C)
6′	26	20 mesh	650	Steel	23	..	..	..	..	..	(C)
6′	26	20 mesh	650	C I	..	18	22	22	22	..	(C)
8′	18	7 mm.	240	Steel	8	20	20	15	15	..	(C)
8′	18	7 mm.	240	C. I	..	..	..	19	19	19	(C)
8′	18	7 mm.	240	Mang.	..	..	..	..	..	15	(C)
8′	18	7 mm.	240	C. I	11	16	20	20	20	20	(C)
8′	18	7 mm.	240	Mang	8	16	..	..	..	..	(C)

C indicates closed circuit; O indicates open circuit.

Ball Mill Sections

Ball Consumption

Maker	Material	Cost per lb.	Lbs. used	Dry tons ground	Lbs. per ton	Cents per ton
A	Cast Iron	2.465	49,800	15,495	3.21	7.913
B	Cast Iron	2.600	84,000	29,817	2.82	7.332
C	Cast Iron	2.582	82,040	25,271	3.25	8.391
B	Cast Iron	2.600	71,050	23,247	3.06	7.956
D	Forged Steel	3.600	81,561	31,858	2.56	9.216
E	Forged Steel	4.590	72,490	38,798	1.87	8.594
D	Forged Steel	3.600	83,453	34,183	2.44	8.784
F	Forged Steel	4.233	84,040	.....	....	.....

Table VII. Details of Grinding Circuits

WEST MILL—LOW-GRADE MIDDLING CIRCUIT

Product	Weight, tons per 24 hours	Moisture per-cent	Screen sizes—Tyler Standard sieves-mesh: On 3	4	6	8	10	14	20	28	35	48	65	100	150	200	—200
Feed	210	15.8	0.9	12.2	23.3	15.9	12.6	8.8	6.3	4.5	3.4	3.2	4.2	3.5	0.9	0.2	0.1
Discharge	912	29.8	...	0.5	0.8	0.9	1.4	1.7	2.9	4.7	8.1	12.0	14.5	17.7	9.3	5.6	19.9
Classifier sand	702	22.3	...	...	0.6	0.4	0.9	1.6	2.9	5.9	10.4	15.1	19.4	19.6	9.5	4.8	8.9
Classifier overflow	210	74.9	...	...	...	...	...	...	...	...	...	...	0.6	5.9	10.2	11.2	72.1

WEST MILL—HIGH GRADE MIDDLING CIRCUIT

Product	Weight, tons per 24 hours	Moisture per-cent	Screen sizes—Tyler Standard sieves-mesh: On 3	4	6	8	10	14	20	28	35	48	65	100	150	200	—200
Feed	186	15.8	1.5	19.1	22.8	12.5	10.3	7.2	4.7	4.7	4.7	2.6	3.1	3.8	2.1	0.7	0.2
Primary discharge	186	49.0	...	...	...	...	0.5	1.1	2.4	5.0	7.6	9.8	10.2	12.2	8.0	6.7	36.5
Classifier sand	1,250	17.5	...	...	...	0.4	0.7	1.2	2.6	5.4	10.7	15.4	20.6	22.0	9.6	5.0	6.4
Secondary discharge	1,250	23.9	...	...	...	...	0.2	0.3	1.1	3.1	7.6	13.8	20.0	21.8	10.2	5.9	16.0
Classifier overflow	186	73.4	...	...	...	...	...	...	...	...	...	...	1.6	7.3	10.7	11.1	69.3

Table No. XI gives the historical metallurgical data for the West mill since 1905. It is interesting to note the rise in silver recovery in proportion to the lead in the later years as flotation plays an increasingly important part in the operations and particularly since the recovery of zinc in zinc concentrates has been instituted. It may be well to explain the figures indicated by "Economic Extraction," as used in this and succeeding tables. This basis of estimating the efficiency of the concentrators has been used at the Bunker Hill mills for the past 20 years. It involves the metallurgical recoveries and the conditions due to smelter contracts for treatment of the products and freight and treatment. It is the ratio of the gross market value of the mill feed to the net smelter value of the products shipped to the smelter, using the same market prices for the metals in both cases.

Table IX. Details of Launders

Size of product conveyed	Percent of solids	Grade, inches per foot	Width, inches	Dry tons conveyed per 24 hours	
15 mm. to 7 mm.	16.1	3¼	6	30	(A)
15 mm. to 7 mm.	12.8	3	6	10	(A)
3 mm. to 20 mesh	20.0	2⅞	4	2.5	(A)
15 mm. to 7 mm.	27.0	4⅛	8	121	(A)
30 mm. to 15 mm.	17.2	3 7/16	6	97	(A)
7 mm. to 20 mesh	10.9	3	6	30	(A)
3 mm. to 20 mesh	6.8	2⅝	4	6	(B)
16 mesh to 65 mesh	23.8	1½	6	60	(B)
65 mesh to 100 mesh	9.7	1¼	6	20	(B)
150 mesh to 200 mesh	15.6	1¼	6	10	(B)
200 mesh	11.2	1⅝	6	10	(B)

(A) Chilled cast iron liner; (B) Mild sheet steel liner.

Table XII graphically represents the costs of milling since 1905. It should be noted that during the past three years a crew of millwrights has been engaged in repairing the timber structure of the West mill, which has had to be largely replaced, and this cost has been included in the miscellaneous cost in the table.

Tables XI and XII will be found on page 612

Table X. Analysis of Shipping Product

WEST MILL

	Ounces per ton		Percent												
	Au	Ag.	Pb	Zn	Cu	Fe	Mn	Sb	As	CaO	S	Cd	Co	Al_2O_3	Insoluble
Jig and lead flotation concentrates..	..	30.9	69.9	5.0	0.22	4.8	...	0.15	0.02	....	15.6	.....	.....	0.50	3.1
Table middlings	..	2.8	3.0	4.9	0.10	32.9	3.4	0.03	0.01	....	4.9	.....	.....	....	7.0
Flotation zinc concentrates.....	..	6.7	1.6	56.0	0.22	5.7	0.3	0.07	0.08	0.12	29.0	0.012	0.004	2.80	1.9

Table XIII. Cost of Milling, 1930

Cost details, 455,475 tons	Average cost per ton for the year
Superintendent and foremen.....	.026
Shift bosses and sampler.....	.016
Crushermen	.004
Conveyormen	.008
Machine operators	.077
Oilers	.021
Roustabouts	.021
Laborers	.005
Experimental	.005
Gyratory crusher repairs.....	.002
Symons crusher repairs.....	.002
Screen and trommel repairs.....	.010
Roll repairs	.011
Conveyor repairs	.011
Elevator repairs	.007
Feeder repairs	.002
Jig repairs	.008
Ball mill repairs.....	.006
Ball mill liners.....	.017
Ball mill balls.....	.052
Pump repairs	.014
Classifier repairs	.007
Table repairs	.016
Flotation repairs	.022
Flotation reagents	.046
Transmission material	.001
General machine parts.....	.008
Spout liners	.005
Oil and waste	.004
Miscellaneous	.024
Machine shop repairs.....	.010
Electrical repairs	.014
Construction repairs	.027
Mill shop repairs	.069
Electric power	.145
Compressed air	.002
Water	.037
Heating	.020
Assaying	.012
Train service	.001
Fire protection	.011
Insurance	.014
Contingent expense	.036
Administrative expense	.072
Truck service	.002
Accidents	.012
Free rent, light, water.....	.003
Total cost per ton.....	$.945

The sharp decline in the grade of the lead concentrates, as to the lead and silver content for the year 1930, is due to the shipment of a low grade product for smelter flux, which heretofore has not been included and designated as concentrates, but is now being shipped with the concentrates. This not only brings the total grade of the product down, but also lowers the curve for economic extraction.

Table XIV. Distribution of Milling Costs—Cents per ton

	Crushing and conveying	Screening	Jigging	Grinding	Concentrating	Flotation	Totals
Labor	.031	.018	.058	.023	.026	.030	.183
Supplies	.015	.004	.028	.114	.025	.078	.275
Power	.012	.006	.029	.054	.014	.029	.145
Miscellaneous	.046	.037	.067	.074	.054	.073	.342
Totals	.104	.065	.182	.265	.119	.210	.945

Table XV. Economic Milling Data—(West Mill)

Days run	355.13
Dry tons milled	455,475.00
Assay feed, percent lead	10.32
Assay feed, ounces silver	4.10
Assay feed, percent zinc	1.71
Contents feed, tons lead	47,025.72
Contents feed, ounces silver	1,866,632.29
Contents feed, tons zinc	7,746.36
Dry tons lead concentrate	83,465.72
Assay lead concentrate, percent lead	52.12
Assay lead concentrate, ounces silver	20.82
Assay lead concentrate, percent zinc	2.77
Contents lead concentrate, tons lead	43,506.24
Contents lead concentrates, ounces silver	1,737,594.17
Contents lead concentrate, tons zinc	2,310.39
Percent extracted in lead concentrate, lead	92.52
Percent extracted in lead concentrate, silver	93.09
Percent extracted in lead concentrate, zinc	29.83
Dry tons zinc concentrate	5,001.55
Assay zinc concentrate, percent lead	2.49
Assay zinc concentrate, ounces silver	6.03
Assay zinc concentrate, percent zinc	56.08
Contents zinc concentrate, tons lead	124.49
Contents zinc concentrate, ounces silver	30,183.47
Contents zinc concentrate, tons zinc	2,805.07
Percent extracted in zinc concentrate, lead	.26
Percent extracted in zinc concentrate, silver	1.62
Percent extracted in zinc concentrate, zinc	36.21
Dry tons mill product	88,467.27
Contents mill product, tons lead	43,630.64
Contents mill product, ounces silver	1,767,777.64
Contents mill product, tons zinc	5,115.46
Percent extracted in mill product, lead	92.78
Percent extracted in mill product, silver	94.70
Percent extracted in mill product, zinc	66.06
Dry tons middlings	1,921.60
Percent extracted in middlings, lead	.13
Percent extracted in middlings, silver	.43
Percent extracted in middlings, zinc	1.12
Summary	
Number tons milled per 24 hours	1,282.60
Number tons lead concentrate produced per 24 hours	235.00
Number tons zinc concentrate produced per 24 hours	14.10
Number tons mill product produced per 24 hours	249.10
Number tons lead produced per 24 hours	122.90
Number ounces silver produced per 24 hours	4,977.80
Number tons zinc produced per 24 hours in zinc concentrate	14.40
Value feed—lead, silver and zinc	$6,582,890.60
Value concentrate—lead, silver and zinc	$3,646,219.14
Economic extraction—percent lead, silver and zinc	55.40
Economic extraction—percent lead and silver only	61.98
Shipping	
Tons concentrates shipped	88,673.54
Cost per ton concentrate shipped	.152

Table XVI

GROSS VALUE OF ORE AT THE MINE AND DETAILS OF CONCENTRATES PRODUCED DURING THE YEAR

PRODUCT	Tons Produced	Assays % Lead Wet	Assays Oz. Silver Wet	Assays % Zinc Wet	Pounds Lead	Ounces Silver	Pounds Zinc	Assay Value Per Ton Lead	Assay Value Per Ton Silver	Assay Value Per Ton Zinc	Actual Gross Value of Product
Lead Concentrates	81,544.05	53.37	21.34	2.72	86,881,105	1,731,812 14	4,436,696	$58 492	$8 040	$ 2 442	$5,624,441 20
Zinc Concentrates	5,001.55	2.49	6.03	56.08	248,797	30,183.47	5,610,135	2 758	2 305	50 442	277,808 04
Middlings	1,921.67	3.42	3.91	4.70	131,374	5,782.03	184,084	4 168	1 305	4.908	16,949 79
Mill Product	88,467.27	49.32	19 90	5.78	87,261,276	1,767,777.64	10,230,915	54.161	7.570	5 209	$5,921,999 03
Tailings	367,007.73	.93	.27	.72	6,790,163	96,854 65	5,261,802	1.039	110	651	660,901 58
Concentrating Ore	455,475.00	10.32	4.10	1.71	94,051,439	1,866,632.29	15,492,717	11.357	1.559	1 537	$6,582,890 61
Total Mine Product	455,475.00	10.32	4 10	1 71	94,051,439	1,866,632.29	15,492,717	$11 357	$1.559	$ 1 537	$6 582,890 61

Lost in Tailings:—Lead, 7.22%; Silver, 5.50%, Zinc, 33.96%; Total Loss, 10.04%.

APPROXIMATE COST AND SELLING VALUE OF YEAR'S PRODUCTION

COST	Tons	Cost	Amount
Concentrates	88,467.27	$24.840	$2,179,037.47
Shipping	88,467.27	.153	13,458.52
Cost on Cars at Kellogg			$2,193,095.99
Lead Loss by Fire Assay			102,122.27
Lead Discount			470,024.72
Silver Discount			35,211.55
Zinc Discount			295,006.12
Freight and Treatment			1,409,413.23
Total Smelting Cost			$2,275,779.89
Total Cost			$4,468,865.88

SELLING VALUE — Production	Quantity	Average Price	Amount
Lead in Pounds	87,261,276 00	$0.0549	$4,791,507 70
Silver in Ounces	1,767,777 64	.3788	669,654 43
Zinc in Pounds	10,230,915 00	.0450	460,838 90
Total Value			$5,921,999 03
Less Cost			4,468,865 88
Profit			$1,453,133 15

Kellogg Cost per Pound of Lead	$0.0251
Smelting Cost per Pound of Lead	$0.0261
Total Cost per Pound of Lead	$0.0512

PRODUCTION BY LESSEES—In addition to the above Production from Company operations, there was produced by Lessees working in Company ground during the year ores having a net Smelter value of $144,537.95 from which the Company received Royalties of $21,747.73.
The total lead, silver and zinc yield from Company and Lessee operations was as follows:

	Pounds Lead	Ounces Silver	Pounds Zinc
Company Operations	87,261,276	1,767,777.64	10,230,915
Lessee Operations	3,973,879	75,255.82	
Total	91,235,155	1,843,033.46	10 230,915

Table XVII will be found on page 613

Table XVIII—HISTORICAL SURVEY OF OPERATIONS.

YEAR AND MONTH (Dates Inclusive)	Ore Mined	Total Gross Assay Value of Ore Recovered	Net Smelter Returns	Operating Profit (Before Depletion)	Other Net Revenue after Providing for Income Taxes	Dividends Paid
May, 1886 to July, 1887	26,855	$ 637,530.40	$ 297,800.01			
Aug., 1887 " May, 1888	33,907	1,654,900.69	772,114.90	$ 458,775.28	.....	.....
June, 1888 " " 1889	39,784	734,968.02	332,014.30	171,973.39	.....	.....
" 1889 " " 1890	No ore mined	or treated.	.....	.....	.....	$ 150,000.00
" 1890 " " 1891	17,092	158,494.77	76,961.97	35,805.37	.....	.....
" 1891 " " 1892	52,114	766,221.80	434,192.35	233,047.08	.....	.....
" 1892 " " 1893	105,287	1,226,167.55	683,786.40	256,352.90	.....	.....
" 1893 " " 1894	99,657	1,158,408.08	586,358.32	286,110.33	.....	60,000.00
" 1894 " " 1895	71,084	562,500.68	267,527.97	73,147.72	.....	15,000.00
" 1895 " " 1896	142,976	897,295.12	535,527.91	160,467.38	.....	36,000.00
" 1896 " " 1897	171,359	1,122,930.42	665,065.14	170,428.74	.....	9,000.00
" 1897 " " 1898	187,243	1,566,949.42	945,024.91	474,346.85	.....	183,000.00
" 1898 " " 1899	178,568	1,519,244.54	917,168.58	399,956.17	$ 27,163.06	246,000.00
" 1899 " " 1900	160,035	1,862,729.42	1,169,766.69	614,123.90	17,108.34	201,000.00
" 1900 " " 1901	227,308	1,663,522.33	978,857.30	318,431.72	22,996.80	252,000.00
" 1901 " " 1902	281,590	1,815,798.68	1,051,686.28	337,696.34	18,474.12	240,000.00
" 1902 " " 1903	260,500	1,623,290.51	897,728.04	211,781.84	32,143,61	45,000.00
" 1903 " " 1904	288,712	1,964,777.82	1,161,765.58	591,477.32	36,205.09	309,000.00
" 1904 " " 1905	320,056	3,643,401.12	2,077,993.67	1,497,122.25	182,653.57	1,200,000.00
" 1905 " " 1906	347,350	4,784,428.40	2,981,333.60	2,375,263.04	1,465,402.39	3,480,000.00
" 1906 " " 1907	336,630	5,011,807.10	3,293,157.00	2,627,778.20	57,383.70	2,340,000.00
" 1907 " " 1908	335,070	3,391,426.10	2,039,771.70	1,308,751.67	26,841.55	1,380,000.00
" 1908 " " 1909	345,270	3,199,975.90	1,856,932.70	1,095,558.68	30,917.52	825,000.00
" 1909 " " 1910	377,530	3,307,825.80	1,989,529.30	1,200,551.81	42,530.66	668,100.00
" 1910 " " 1911	438,290	3,307,393.69	2,051,664.77	1,110,314.73	34,733.54	1,062,750.00
" 1911 " Dec., 1912	702,520	5,396,915.51	3,416,684.55	1,738,403.69	80,804.60	1,209,900.00
Year 1913	436,060	3,890,139.16	2,329,888.27	1,167,317.62	118,433.37	817,500.00
" 1914	440,819	3,362,498.96	2,010,136.70	973,355.23	160,257.87	981,000.00
" 1915	455,205	4,177,819.20	2,384,543.28	1,241,031.88	603,637.16	1,062,750.00
" 1916	475,784	6,253,048.40	3,297,827.25	1,844,758.05	520,282.26	1,716,750.00
" 1917	493,030	9,584,963.40	4,943,782.37	3,285,827.04	240,443.13	2,043,750.00
" 1918	389,027	6,094,285.69	3,949,878.07	2,533,888.71	387,211.34	1,553,250.00
" 1919	393,698	5,093,825.78	3,362,191.62	1,765,992.92	92,730.77	1,144,500.00
" 1920	409,986	6,915,140.75	4,586,976.26	2,967,683.02	561,066.39★	1,962,000.00
" 1921	426,530	4,612,444.96	2,695,594.42	874,438.17	643,303.53★	981,000.00
" 1922	421,532	5,171,228.19	3,332,543.17	1,772,703.24	274,436.71	1,062,750.00
" 1923	425,817	5,968,275.09	3,959,802.51	2,174,019.98	70,008.25★	1,635,000.00
" 1924	422,907	6,755,521.90	4,592,072.08	2,751,005.70	174,552.96	1,962,000.00
" 1925	453,412	7,766,169.74	5,439,765.76	3,415,092.43	643,222.73	2,959,209.78
" 1926	459,761	7,202,042.50	4,949,692.80	2,858,683.64	895,496.53	2,981,709.90
" 1927	456,134	6,910,720.58	4,705,667.86	2,567,189.15	789,961.30	2,993,628.06
" 1928	452,345	6,711,631.12	4,366,031.97	2,156,631.12	770,718.07	3,003,962.47
" 1929	451,111	7,188,837.42	4,659,910.36	2,170,865.45	820,629.10	3,009,042.00
" 1930	455,475	5,921,999.03	3,846,219.14	1,184,631.00	1,032,359.10	2,109,690.40
Totals	13,465,420	$162,559,495.74	$100,693,437.83	$55,452,780.75	$8,325,352.78	$47,891,242.61

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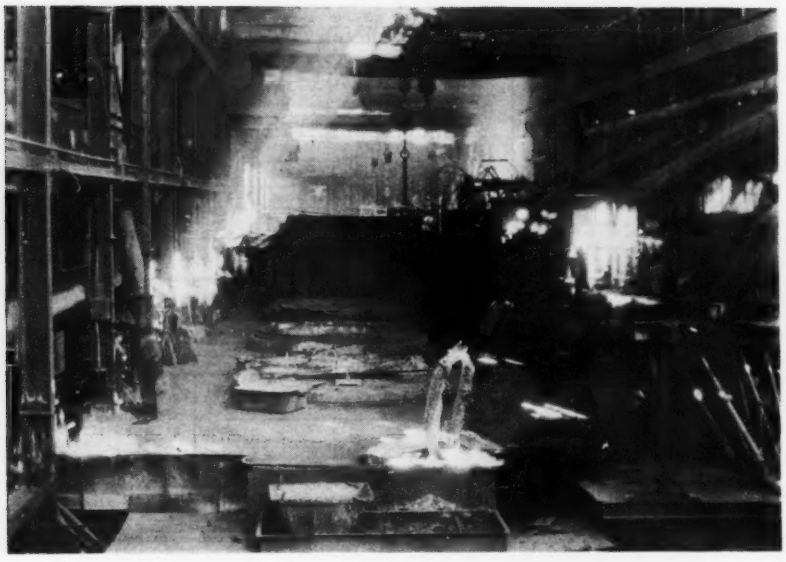

Drossing kettles in the center, softening furnaces on the right, and blast furnaces in the distant right

The Bunker Hill SMELTER

By
A. F. Beasley*
P. C. Fedderson†
J. B. Schuettenhelm†
J. W. Johnson‡

Sampling

UPON arrival at the smelter, the cars of ore and concentrates are weighed, and immediately thereafter a sample for moisture is taken by the customary method.

Most all ores and concentrates received are sulfides requiring roasting; consequently, any which are coarser than four mesh are crushed and automatically sampled for control sample in the sample mill. Those finer than four mesh are sampled by one of two well-known methods—tenth shovel or by auger. All which are applicable are auger sampled. If either too dry or too wet, they are sampled by the tenth shovel method.

For the tenth shovel method, the men unloading the car reserve every tenth shovel for the sample. This sample is then cut down by coning and quartering to proper size. Half of the final sample is sacked for a reserve sample, and the other half is sent to the assay office for final preparation and assaying.

Auger samples are taken with a 2-in. wood auger. The auger is inserted through a pipe nipple in the center of the sample pan, the borings being caught in the pan. From 40 to 500 holes, depending upon the size of the car and the grade and uniformity of the material, are bored. The borings constitute the sample and are thoroughly mixed, coned and quartered to convenient sample size.

As before stated, the coarse ore and concentrates are crushed and sampled in the sample mill. Let it be understood that there are no elevators in the mill, and that all transporting of material between operations is done by means of rubber belt conveyors.

Ores over 4-in. size are crushed and sampled as follows:

First, by 18 in. x 24 in. Allis-Chalmers Jaw Crusher to 2½ in.; next, by 42-in. horizontal Symons Disc Crusher to 1½ in.; next, by 18 in. x 42 in. Traylor Heavy Duty Rolls to minus ¾ in.; next, screened by Hummer Vibrating Screens with 80 sq. ft. screening area of screen cloth, with ¼-in. openings; oversize from screen to second set of Traylor Finishing Rolls, reducing size to minus ¼-mesh (finishing rolls and screen are in closed circuit); undersize from screen through Vezin sampler, which takes 1/10 or 1/20 cut, depending upon size of lot; this cut through 12 x 16 sample rolls, crushing to minus 10 mesh, to a second Vezin sampler, which takes 1/10 or 1/20 cut, which is spouted to the sample room, where the sample is reduced to convenient size by passing through splitters.

Ores and concentrates ranging in size from plus ¼ in. to minus 2½ in. are not primarily crushed in the Jaw Crusher, but go direct to the Symons crusher.

After crushing and sampling, the material is conveyed to the roaster charge bins, of which there are 17, each with a capacity of 3,300 cu. ft.

Oxidized ores suitable for direct blast furnace smelting do not require fine crushing. These are crushed in the jaw crusher, as above, sampled by a Vezin sampler which takes 1/5 or 1/10 cut. The sample is crushed to minus 1 in. in a 6-in. Traylor Gyratory Crusher. It is next taken to a second sampler, which takes ¼ or ⅛ cut. This cut goes through a 12-in. x 16-in. sample roll to third sampler, which takes 1/10 or 1/20 cut, which is spouted to the sample room and prepared, as above described, for the final sulfide sample. After crushing and sampling, oxide ores are conveyed to railroad cars for transporting to blast furnace charge bins.

D. & L. Roasting

TEN standard Dwight & Lloyd Roasters are used for preparing the charge for blast furnace smelting. For proper blast furnace operation, and to eliminate any matte-fall therein, the sulfur in the final sinter must not exceed 2.0 percent. Due to increased amounts of zinc sulfide, and ever increasing amounts of wet flotation slimes, it has been found necessary to double roast all of the sulfide ores and concentrates to oxidize and reduce the sulfur to a minimum.

From the roaster charge bins the material is drawn by feeder belts which discharge onto a common cross belt, which conveys the charge to the upper floor of the D. & L. Building, where it is discharged by means of a tripper to the charge hoppers over each machine. Enroute to the charge hoppers, the material passes through a 42-in. Stedman Disintegrator. This machine consists of two squirrel cages, one within the other, rotating in opposite directions at speeds of about 100 r. p. m. The charge is fed inside the inner cage, the object being to break up any lumps, as well as to mix the charge.

From the charge hoppers, the material drops onto the center of a 6-ft. mixing

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† Assistant Smelter Superintendents.
‡ Superintendent, Lead Refinery.

table, where the charge is mixed and water is added to condition it for proper roasting. From the mixing table, over each machine, the charge drops through an oscillating spout onto the back end of the roaster. The roasters are fired with oil in a brick combustion chamber. Each machine is equipped with a 10-in. x 66-in. suction fan driven by a 50-hp. motor. These fans supply the necessary air for sulfur oxidation by drawing it through the bed of material on the machines. The fume-laden discharge from the fans is collected in a flue in which it is transferred to the Cottrell plant for treatment.

As the pallets, carrying from 4 to 8 in. of charge, pass under the oil burner chamber, the heat is drawn down into the bed and ignition takes place. Once started, the oxidation of sulfur continues as long as sufficient air is supplied or until the material is discharged.

Five machines are used for preroasting, and five for final roasting. Between the preroasting and final roasting operation, the material is crushed to minus ¾ in. About 20 percent is plus ¼ in., of which about 5 percent is plus ½ in. The balance, 80 percent, is minus ¼ in.

A recent innovation for collecting and conveying the preroasted material to the crushing plant has effected a remarkable saving, of loss from dusting, over the former procedure of collecting in railroad cars for transporting to the crushing plant. The conveyor is a 26-in. tubular vibrating conveyor made by the Traylor Vibrating Company, Denver, Colo. Essentially the principle is the same as that employed in vibrating screens. In screens, vibration is imparted at right angles to the screen cloth. In the conveyors, vibration is imparted at an angle to the longitudinal axis of the tube, so that as the tube moves forward in the direction of conveying, it also moves upward, and as it moves backward it also moves downward. This causes the material inside the tube to travel at varying speeds up to 50 ft. per minute, depending on the amplitude of vibration.

The vibrating conveyor discharges into a small surge hopper over a Trail screw crusher. The crusher is a 4-ft. cast iron chamber with a grizzly bottom and front end. Longitudinally through this chamber is a shaft to which are bolted 18-in. diameter cast iron flights, which produce a crushing action similar to a meat chopper. The discharge from the screw crusher or "meat chopper" is conveyed in a 20-in. vibrating tube to a chain elevator which discharges onto a 3 ft. x 6 ft. Traylor Vibrating Screen, type RV2, the oversize passing through a 16-in. x 42-in. Allis-Chalmers smooth rolls. The undersize from the screen and the roll product are collected in another 20-in. vibrator tube, which discharges on the center of a 10-ft. revolving mixing and cooling table. The material as it is being rabbled to the edge of the table, where it is discharged, is sprayed with water, so it is moist and cool when transported on a 20-in. rubber belt conveyor to the storage bin for the final roast charge.

Molten lead from blast furnace being poured into drossing kettle from 5-ton bullion pot by means of the 20-ton traveling crane

The discharge end of the first roast machines, also the chutes discharging into the conveyors, as well as the screw crusher, elevator, screen, rolls, and cooling or mixing table, are enclosed and are dust tight.

The steam, carrying some dust, is collected from these various enclosures into a common flue, passed through a lead-lined chamber, where it is sprayed with water at 250 pounds pressure; thus the dust is knocked down and the steam escapes through a short stack. The spray water carrying the dust is pumped to a Dorr Thickener. The thickened solution is filtered by an Oliver filter; the filter cake constitutes a portion of the preroast charge.

The product from the final roast machines is discharged into bottom dump railroad cars for transfer to blast furnace charge bins.

The first roast machines run at a pallet speed of 20 to 24 in. per minute, producing from 6½ to 8 tons of roast per hour per machine. The final roast machines have a pallet speed of 12 to 15 in., producing 4 to 5½ tons per hour.

A typical analysis of preroast feed, preroast, and final roast is given below:

	Oz Au.	Oz. Ag.	% Cu.	% Pb.	% Fe.	% Insol.	% CaO.	% S.	% Zn.
Feed	...	42.3	.4	50.8	11.5	7.2	7.00	12.3	3.5
Preroast	...	42.0	.5	54.0	11.7	9.2	7.2	6.1	3.7
Final roast	.30	34.0	.5	48.0	13.4	9.7	7.4	2.0	3.9

It is notable that the final roast is lower in lead and silver than the preroast. This is for the reason that when roasting so high a lead charge the second time, considerable lead, carrying silver, is liquated and seeps through the grates into the windboxes, from which it is removed as metallic lead.

Blast Furnaces

TWENTY-THREE bins of 3,300 cu. ft. capacity each are designated as "blast furnace charge bins." Eight of these are of concrete construction, and are used for roast storage. The remainder are used for coke, limerock, siliceous ores, zinc plant residues, refinery drosses, baghouse dust and slag. The blast furnace charge is drawn from the various bins through two arc gates, for each bin, into suspended weighing hoppers. From these hoppers, the charge then is dropped into a two-compartment charge car, each compartment of which will hold a complete charge of 3,000 to 4,000 lbs.

The arrangement includes a charge bin, scale, scale hoppers, and charge car. There is also a unique crusher for breaking up large coke. This is essentially a shaft, with five staggered fingers, on the crushing end, driven by a 10-hp. motor through a speed reducer. Below and in front of the fingered end of the shart are grizzlies with 6-in. square openings. The grizzly allows the smaller coke to drop through, while the larger pieces are mashed by the revolving arms on the shaft. This gives a uniform size of coke, not larger than 3 in. Formerly, coke was crushed in the sample mill at considerable expense. Now it is done by the operator who weighs the charge, at no additional cost.

The charge car, when loaded, is run over the open top of the blast furnace and the charge dropped into the furnace. There are three blast furnaces in readiness, while a fourth can be put in condition on short notice. These furnaces are 48 in. x 180 in. at the tuyeres, and 20 ft. 9 in. deep from the feed floor to the tuyeres. The crucible is 2 ft. 3 in. deep. Two tiers of water jackets form the sides and ends of the blast furnace. The lower tier jackets are 6 ft. 6 in. long, and the upper are 7 ft. 6 in. long. From the top jacket to the feed floor is a cast steel shaft. There are five jackets for each side, each jacket having two 4-in. tuyeres. Cooling water circulates first through the upper jackets, from the upper jackets through the lower jackets, and discharges to cooling and storage reservoir for re-use.

Air is supplied by a Connellsville Blower, having a displacement of 140 cu. ft. per revolution. running at a speed of 100 r. p. m. Each furnace requires 5,000 to 6,000 cu. ft. of air per minute. The blast pressure is from 22 to 28 ozs. per sq. in. From 8 to 9 ft. of charge are carried in the furnace. Each furnace consumes about 350 tons of charge, exclusive of coke, per 24 hours. The coke added is from 10 to 11 percent of the charge. The charge is 50 to 53 percent lead. As the charge descends in

the column and enters the smelting zone, the lead is reduced to metallic lead by reducing gases from the coke, and the iron, silica, lime and zinc combine to form slag. The lead, carrying the gold, silver, copper, antimony, and arsenic, being heavier, settles to the bottom, or crucible of the furnace, from which it overflows through a syphon at the side of the furnace, commonly called the "leadwell." The slag collects in the furnace in the 1-ft. 2-in. space between the top of the crucible and the tuyeres. It is tapped from the front end of the furnace through a tap-hole at an elevation about 3 in. above the crucible. The slag passes into a settler, overflows into a second, and discharges into a 130-cu. ft. slag pot, in which it is transferred to the dump.

The lead is collected in a 5-ton bullion pot, in which it is transferred by means of a 20-ton traveling electric crane to the refinery.

Hoods, which are connected to the main flue, have been placed over the leadwell and slag discharge for the purpose of saving the fume, but primarily to safeguard the health of the operators.

Fumes from the blast furnace pass through a brick flue to the baghouse.

A typical blast furnace charge and the resultant slag are given below:

D. & L. roast	88.0%
Lime rock	1.0%
Siliceous ore	1.0%
Zinc plant residue	3.5%
Baghouse dust	3.5%
Slag and cleanup	1.5%
Refinery drosses	1.5%

To the above charge from 10 to 11 percent of coke is added.

A slag analysis is as follows:

Ag.	Cu.	Pb.	FeO.	MnO.	SiO_2	Al_2O_3	CaO.	MgO.	S.	ZnO.
.10 oz.	.10%	.8-1.3%	36.3%	2.4%	24.4%	6.2%	15.8%	2.2%	2.8%	10.0%

With the Zinc Plant running to capacity, the normal slag is increased to about 15.0 percent ZnO.

Lead Refinery

Drossing

THE lead refinery occupies the west end and the blast furnaces the east end of the same building. Each department is equipped with a 20-ton traveling electric crane, each of which can serve either department, and to each is hung a suspension-type scale.

The blast furnace crane delivers the hot lead in 5-ton brick-lined pots to two of the six 100-ton drossing kettles. When one of these kettles is nearly full, drossing is commenced with the aid of the crane, using a 5-ton kettle as a skimmer. This dross is dumped upon a 9-ft. square drossing plate, broken up with bars, hammers, and at times with a small air drill or jack-hammer, shoveled into skips, weighed, and stored for treatment in the by-product furnace.

When this heavy dross has been removed, the bullion is pumped into a clean kettle, using a Rumsey pump, which delivers 5 tons per minute. Then a pipe is inserted into the bath and air is blown in until the lead begins to freeze. At this stage the lead is heated to about 630 degrees F., and skimmed by hand with a perforated skimmer. This second skim, being high in lead, is returned to the first dross kettle to be mixed with the next bullion charge. This process of drossing and blowing lowers the copper content from .90 to .04 percent.

This dross amounted to 9.5 percent of the total bullion for the year 1930, and assayed:

Au.	Ag.	Cu.	Pb.	Sb.
.45 oz.	97.8 oz.	8.0%	77.1%	.98%

Softening

THE lead is now heated to about 900 degrees F., and pumped into one of two 350-ton softeners, through a steel launder which has a lining 3 in. thick on the sides and 4 in. thick on the bottom, made of two parts cement and five parts limestone crushed to approximately 20 mesh. This launder is open-topped, 8 in. deep, 5 in. wide at the top, and 4 in. wide at the bottom, 52 ft. in length, and discharges into a 6-in. pipe leading to the furnace through a side door.

The time required for softening depends upon the antimony and arsenic content. A bullion varying from 1 to 1.5 percent antimony and .10 to .25 percent arsenic can be softened in 15 to 20 hours. The furnace heat varies from 1,600 degrees F. to 1,800 degrees F.

Practically all of the antimony and arsenic collects as a crust and is skimmed off when the next bullion charge is pumped into the softener. This skim amounted to 4.5 percent of the bullion in 1930, and assayed 6.46 oz. Ag., 18.6 percent Sb., 2.3 percent As., and 62.6 percent Pb.

Desilverizing

AFTER the softened bullion has been skimmed and cooled to about 1,000 degrees F., 200 tons are tapped into one of three 225-ton desilverizing kettles. The lead oxide dross which forms during tapping is skimmed and returned to the dross kettles.

Zinc is added in excess of that which is necessary to remove the gold, insuring a complete separation of the gold from the silver. The "gold zinc" is agitated for 15 minutes. The agitator is driven by a 30-hp. motor, 860 r. p. m., with a gear reduction having a ratio of 54 to 15, giving a speed to the impellers of about 240 revolutions per minute.

The lead is circulated through a cylinder 29 in. in diameter and 26 in. deep, immersed about 5 in. below the surface of the lead. The temperature during agitation is 900 degrees F. The fire is now shut off and the lead allowed to cool. As the kettle is scraped down and the temperature drops, the gold crust forms and is skimmed off from time to time, and made into blocks.

This process continues for five lots, or kettle charges, the blocks from the previous kettles being put into each succeeding one, pressing on the fifth lot. This is accomplished using a Howard-type press, which takes off about 2,500 lbs. of dross with each press. The total dross from the five lots amounts to about 8 tons, or .9 percent of the bullion.

The gold dross is now weighed and sent to the silver refinery.

In the desilverizing kettle the remainder of the silver is taken out by adding additional zinc. The working of the kettle is nearly the same as for gold skim. About eight blocks made from the previous lot are added, melted, and agitated at 900 degrees F. for about 15 minutes. The silver dross is then passed off, weighed, and taken to the silver refinery. Next the zinc is added, stirred in, and blocks made by cooling and scraping down the sides of the kettle. When the lead begins to freeze, the ring is pulled and set aside to be returned to the kettle with the next charge.

The silver dross for 1930 was 2.5 percent of the total bullion. The desilverized lead contains from .5 to .6 percent zinc and .10 percent antimony when it is heated to about 750 degrees F. and pumped to one of two refiners, each having a capacity of 250 tons. The pumping is accomplished with a Rumsey pump, having a 30-hp. vertical motor, making 900 r. p. m., and capable of delivering 9 tons of lead per minute.

The refiner temperature varies from 1,300 up to 1,800 degrees F. When the lead reaches about 1,200 degrees, blowing is commenced. The first blow takes from two to three hours, depending upon the temperature and impurities

Drossing kettle being agitated with air to reduce the copper content of the lead bullion. Hand skimmers are shown on the side of the kettle

in the lead. At the end of the first blow approximately 98 percent of the zinc and 50 percent of the antimony has been oxidized and forms a dross which is skimmed off at once, stocked, and finally sent to the blast furnace.

After skimming, a light fire is used to hold the temperature, and a second blow is made which takes the remaining antimony down to .0030 percent and zinc to .0015 percent.

The average time for a charge to go through the refiner is approximately 11 hours. The dross amounts to 3.5 percent of the bullion, and assays:

Ag.	Cu.	Sb.	Pb.	Zn.
.42 oz.	.07%	4.5%	63.3%	15.4%

Casting

The lead in the refiner is allowed to cool to about 900 degrees F., when it is tapped into one of two casting kettles, each having a capacity of 225 tons. From the kettle it is pumped at 700 degrees F. to a casting wheel having 150 moulds, cast into 100-lb. pigs, and loaded into cars for shipment.

A Newnam-type pig puller is used, which pulls five pigs at a time, placing them in tiers seven pigs high, making a 1¾-ton load for a Newnam electrically driven lead-pig truck, which picks up the load, conveys it over two scales and then to stock or shipping cars. Refined lead produced per day per man employed in lead and silver refineries is 4.2 tons. This figure includes not only all the labor engaged in the usual lead and silver refinery practice but also includes the labor of drossing blast-furnace bullion and the treatment of the resulting dross and low-grade matte.

Treatment of Copper Dross

THE copper dross is charged into a 75-ton reverberatory, or by-product furnace, with 1 percent silica and 1 percent lime rock. The bullion produced assays approximately the same as the original bullion, and amounts to about 64 percent of the weight of the dross charged to the furnace. This bullion is returned to the dross kettles and is treated the same as the regular blast-furnace bullion.

The copper dross slag made amounts to 8.7 percent of the dross charged, and assays:

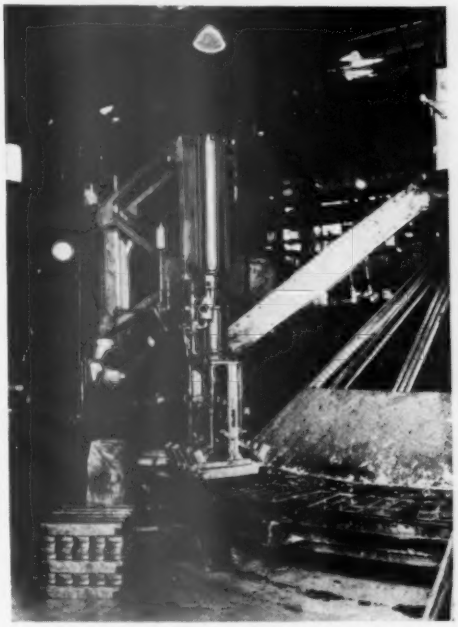
Ag.	Cu.	Sb.	Pb.
6.2%	4.3%	4.6%	35.4%

This slag is returned to the blast furnace.

The matte from the copper dross amounts to 27.7 percent of the dross, and assays:

Ag.	Cu.	Pb.
57.7 oz.	39.5%	38.78%

This matte is retreated in the by-product furnace with 10 percent scrap iron and produces a matte assaying:



Showing operation of Newman type pig puller and a section of the casting wheel

Ag.	Cu.	Pb.	Fe.
53.5 oz.	46.0%	15.8%	15.0%

In this furnace 68.2 tons of copper dross were handled per day.

Treatment of Antimony Skim

This skim is charged into the by-product furnace with 3.5 percent coke and 3.5 percent galena. The bullion produced amounted to 59.5 percent of the skim in 1930, and assayed:

Ag.	Sb.	Cu.	As.
10.5 oz.	2.9%	.55%	1.2%

The antimony slag made amounted to 36.5 percent of the skim and assayed:

Ag.	Cu.	Sb.	Pb.
.8 oz.	.19%	26.0%	44.4%

This slag is stocked and held to be treated in the blast furnace when the antimonial lead run is made, which is once a year.

Fuel Consumption

Coal used per ton of refined lead produced, including complete refining of lead, gold, and silver, 190 lbs.

Oil used per ton of refined lead produced, including complete refining of lead, gold, and silver, 4.6 gallons.

Life of Kettles

The average life of the 100-ton dross kettles is three and one-half years, and 225-ton desilverizing kettles have been 250 heats. This latter figure we expect to exceed by improvements in the manner of tapping.

Silver Refinery

THE silver dross is liquated. The liquating kettle used was developed in Australia. It is a kettle 18 in. in diameter, 60 in. deep, made in two sections, the top half and lower half being bolted together through wide flanges. Between them, in a groove, is placed a half-inch water pipe to form a seal. From the lower part of the kettle a 2-in. pipe extends up high enough to act as a syphon for the liquated lead.

For operating, the lower portion is first filled with desilverized lead, then silver dross is added. Heat is applied to the top section only. The lead liquates out of the zinc-silver alloy, and goes to the bottom and runs out of the syphon pipe. The zinc-silver alloy is ladled out and poured on a water-cooled pan. Forty-eight percent of the charge to the liquating kettle is recovered and returned to silver kettles. This lead is very low in silver. The charge to the liquating kettle is 1,500 lbs. Nine tons of silver dross is liquated per 24 hours. The liquated crust analyzes:

Zn.	Pb.	Ag.
48%	29%	23%

The upper half of the kettle will treat 200 tons before it has to be replaced. The lower half lasts indefinitely.

A 1,200-lb. charge of this crust is retorted in a retort in six hours for complete operation. The average life of the retorts is 60 heats. The retort bullion assays as follows:

Au.	Ag.	Cu.	Zn.
0.10 oz.	12,800 oz	0.10%	2.0%

This bullion is cupelled and the dore metal, which is 997 fine, is further refined in a Monarch tilting furnace.

The gold skim is dirty, because it picks up all the copper in the lead, and also the lead oxides on the kettles after skimming, subsequent to tapping from the softeners. There is also considerable zinc oxide in the dross, due to it being pressed only on every fifth kettle. This is not liquated, but goes direct to the retorts. The retort metal assays:

Au.	Ag.	Zn.
41.94 ozs.	1321.5 ozs.	1.24%

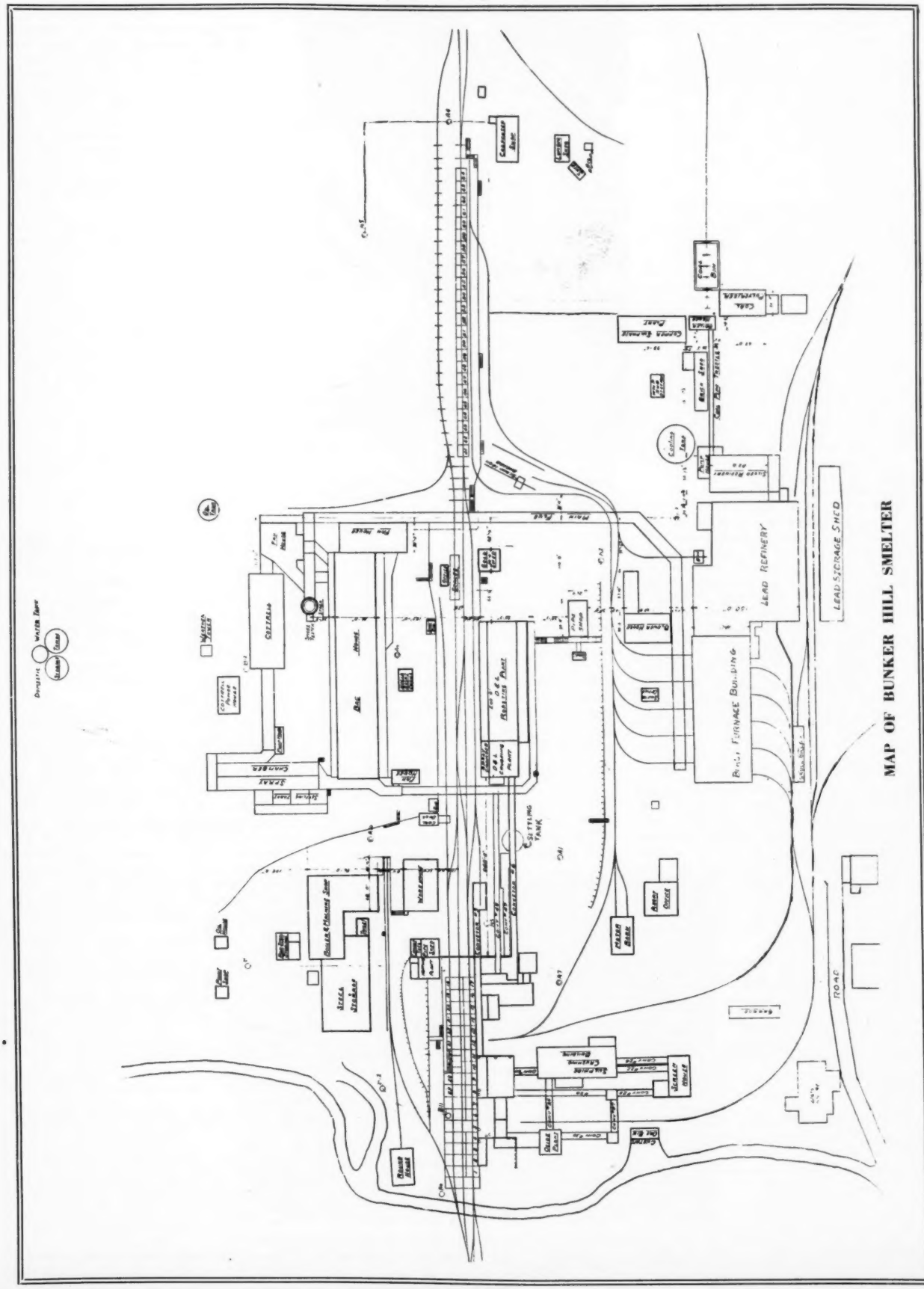
This is cupelled together with the retort dross and clean up. The dore assays:

Au.	Ag.
25.7 fine	965 fine

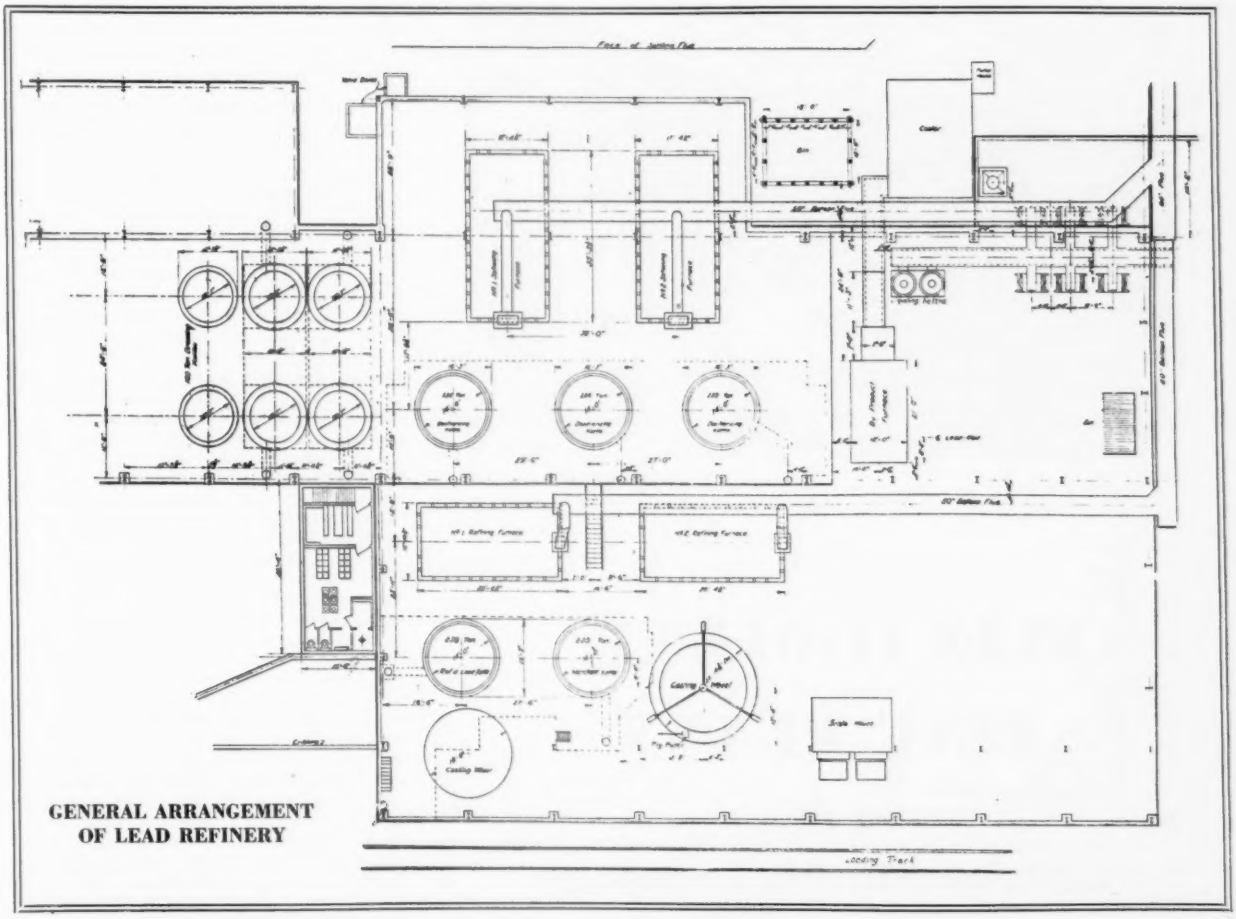
The litharge produced averages 265 lbs. per 1,000 ozs. of gold and silver produced.

This dore is parted with sulphuric acid, and the silver precipitated with metallic copper. The silver is thoroughly washed and melted in the Monarch furnace. All the silver produced is 999+ in fineness.

The copper sulphate solution is evaporated, the copper sulphate crystallized



BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY



GENERAL ARRANGEMENT OF LEAD REFINERY

out, the mother liquor evaporated and concentrated, and the sulphuric acid returned to the system.

Fuel oil is the fuel used in the silver refinery. The consumption of oil in the liquating kettle is 5 gallons per hour, on the retorts 7 gallons per hour, and on the cupel 11 gallons per hour.

The cupel is the Rhodes type, and has a capacity of 100,000 ozs. of silver, and the Monarch furnace has a capacity of 20,000 ozs. of silver.

The cupel is lined with magnesite brick, backed up with ground magnesite on the sides, and the bottom for a depth of 1½ in. is a mixture of the following: 150 lbs. asbestos, 200 lbs. fire clay, and 200 lbs. lime rock. On top of this is a 6-in. layer of the following mixture: 600 lbs. fire clay, 640 lbs. cement, and 1,600 lbs. lime rock. For part of the lime rock, slag, and crushed fire brick have been substituted with good results. The Monarch tilting furnace is lined with special blocks in the lower half and carborundum in the upper half.

Cottrell plant

THE smoke from the D. & L. sintering machines is treated in the Cottrell plant. The maximum volume of gas handled is 120,000 c. f. m.

The temperature of the gas is 250 to 300 degrees F. at the outlet of the D. & L. fans. At the inlet to the spray chamber the temperature is 200 to 250 degrees F., and at the Cottrell inlet the temperature varies from 100 to 125 degrees F. In its passage through the treater, it cools 20 degrees more. The relative humidity at the outlet of the treater is 50 to 60 percent.

The water for spraying in the spray chamber is delivered to the nozzles at 250 lbs. per square inch pressure. From 5 to 20 gallons of water per minute is used, depending on the temperature of the gas and of the atmosphere. The pump installation consists of a triplex plunger pump of 35 gallons per minute capacity, and a centrifugal pump of 50 gallons per minute capacity. Only one is used, the other being a spare. This pump also provides the water for a small spray chamber at the D. & L. plant.

The spray chamber, Cottrell plant, and the connecting flue between them are built of brick, laid in acid-proof mortar. All the roofs were originally concrete, but some of these have been replaced with laminated 2 x 4 wood and roofing paper. This wood was dipped in asphalt before laying.

The Cottrell is pipe-type, down draft, and consists of two rows of seven chambers each. The inlet and outlet flues, and the operating floor are between. Each section has 64 pipes, 16 ft. long and 12 in. in diameter. No. 18 gauge wire is used for the negative electrode.

As the treater pipes are entirely enclosed in the brick building, and the smoke comes down the pipes and up around the outside of them, to the outlet damper, there is no condensation of moisture on them, and therefore no resulting corrosion of the pipes.

The grids for the suspension of the wires, both at top and bottom of the pipes, are supported on insulators set inside of the chamber. This location of the insulators in the chambers prevents the condensation of moisture on them and eliminates their short circuiting.

The pipes and wires are rapped every two hours. The hammers for the pipes are hung on a rod which is moved back and forth by means of an eccentric on a motor-driven shaft. Each hammer raps four pipes. The wires are rapped by means of a rod which is swung between two rows of wires.

The power plant consists of three 15 k. v. a. and one 30 k. v. a. single-phase, alternating-current generators and rectifier sets. This 200-volt current is stepped up to approximately 100,000 volts for the treater. Only three rectifiers are used at a time, and by switch arrangement any of the four rectifiers can be put on either one of the three bus lines to the treater. In the treater, any section can be placed on either one of two bus lines.

The switchboard has automatic equipment for regulating the voltage on the generators; also an automatic timer on the A. C. side for operating the circuit breaker. This timer is set so that when the circuit breaker kicks out it will close the circuit (*Continued on page* 632)

ELECTROLYTIC ZINC PLANT

of the Sullivan Mining Company

By
W. G. Woolf*
R. M. Miller†

THERE is probably no metallurgical enterprise today that has been watched with as much interest by the public and the profession as has the building of the Sullivan Mining Company's new electrolytic zinc plant at Silver King, Idaho. This is, no doubt, due to the fact that it was the first industrial plant using the Tainton high acid, high current density electrolytic zinc process, though previously an experimental and pilot plant had been operating for years producing zinc of exceptional quality and purity.

The new plant has been built near the head of Government Gulch, at Silver King, Shoshone County, Idaho, in the Coeur d'Alene mining district, 1 mile distant from the Bunker Hill smelter and 3 miles from Kellogg. The site is ideal for gravity flow. The main building rests on the hillside, which has a slope of about 17 deg., while the cell, cooling, generator and melting buildings are located on the flat just below. A spur of the O. W. R. & N., passing through the plant yard, furnishes transportation facilities.

The present unit has a nominal capacity of from 60 to 75 tons of cathode zinc every 24 hours, and has been so built that two additional units may be ultimately added. Its feed will be derived from the flotation concentrates of the complex lead-zinc ores of the district and its surrounding territory, as well as from the Star mine, a property owned by the company.

Factors Influencing the Selection of the Process

Zinc electro-metallurgy, from the beginning, has been afflicted with serious inherent difficulties, which have threatened the process with extinction. The roasting of zinc sulphides in intimate contact with iron tends to produce zinc ferrite, which is insoluble in dilute sulphuric acid, with the result that the zinc so combined will be thrown into the leach residue. The leaching of calcines in sulphuric acid solution not only dissolves the zinc oxide, but takes into solution also quantities of iron and silica, which, when the leach is neutralized, are precipitated as ferric hydrate and gelatinous silica, both of which make filtration difficult. The presence of certain impurities in the electrolyte, even in minute amounts, seriously interferes with electro-deposition, and these must be removed. The above and numerous other problems have been experimented with by many notable investigators and solved with various measures of success.

Present practice at plants now successfully extracting zinc electrolytically from sulphate solutions makes use of dilute sulphuric acid in the leach, and a low acid electrolyte, in combination with low current density in the cells.

Tainton's experiments have shown that a high acid electrolyte and a high current density in the cells will give, particularly in the presence of certain colloids, a smoother deposit of zinc on the cathode with a higher current efficiency. This permits the use of a high acid leach in which zinc ferrite produced in roasting is soluble. Due to this fact, roaster temperatures need not be so carefully controlled and greater capacity per roaster, with attendant increased extraction of zinc, results. A greater concentration of zinc in the neutral solution reduces the total amount of solution to be handled per ton of zinc produced, and makes possible the presence of greater amounts of impurities per liter. In addition to this, the higher current density in the cells produces a correspondingly greater amount of zinc per unit of time and cathode area than is the case with the low current density, permitting a smaller cell unit for the same output of zinc. A fuller discussion of these points may be found elsewhere.‡

It may be sufficient to say here that the advantages of the high acid, high current density process have been recognized by many metallurgists, but its special problems and disadvantages have required extensive experimentation on the part of investigators and the ingenuity of Tainton and his staff for their final solution.

Design and Construction

THE experimental work which has culminated in the building of the plant, as well as the construction, has been initiated by and carried on under the management of Stanly A. Easton, vice president and general manager of the Bunker Hill & Sullivan Mining and Concentrating Company. Construction has been under the direction of Walter K. Mallette, superintendent of construction.

* Superintendent, Sullivan Zinc Plant.
† Formerly metallurgist, Sullivan Zinc Plant.
‡ U. C. Tainton and L. J. Leyson, Transactions, A. I. M. E., Vol. 70, p. 486.

Daniel Bosqui, U. C. Tainton, and W. G. Woolf are responsible for the flowsheet and metallurgical design. A large number of machines have been specially designed for their purpose, a staff of 15 designers and draughtsmen having been retained during the period of the building. Practically all building was done by contract; most of the excavation, however, being day labor in charge of the company foreman. An average of approximately 250 men were daily engaged in construction work.

The first work on the building began in October, 1926, and the first roaster was started in August, 1928, 22 months later. Nearly 13,000 cu. yds. of 1:2:5 concrete went into walls, foundations, floors and piers, requiring 78,000 sacks of cement, 344 cars of mill tailings, and 167 cars of sand (table tailings); 506,000 pounds of reinforcing steel were used. The framework of the principal buildings is entirely of structural steel; the walls are of gunite, supported on the steel framework by 4 x 6 in. wall girts and posts and reinforced with triangular mesh wire. One part cement mixed with two and one-half parts of sand is forced through a hose and nozzle from a pressure chamber, and sprayed with water, onto the wire reinforcing, which is backed up with shiplap. After removing the shiplap the other side was sprayed, giving a wall thickness of 1½ in. Wall girts and posts are completely covered and thus made fireproof. All roofs are laminated, 2 x 4-in. on edge, nailed to rafters which are bolted to the steel roof trusses. Every 2 ft. is placed a 2 x 8-in., the whole being solidly nailed together so that each 2-ft. section acts as a T-beam. The designed strength of this type of roof is 45 lbs. to the square foot. Accumulation of ice and snow, however, during the past winter subjected parts of the roof of the main building to a load approximately 250 lbs. a square foot without serious injury. Roof covering is of asphalt impregnated burlap. Windows take up about 25 percent of the wall area.

The Main Building is 216 ft. wide by 306 ft. long, covering an area of a little over an acre and a half. The sloping site permits gravity flow of the solutions and pulps through the various operations, requiring a minimum number of pumps. This building is divided into five floors—the top being the roaster floor, and successively lower are the leach floor, filter and purification floor, storage tank floor, and residue drying floor. All floors are of concrete, and have a slope of about 1 in. in 6 ft. for drainage. Those sections under acid tanks are painted with asphalt in case of spillage. All tanks and machinery are mounted on concrete piers, and individual motor drive, with speed reducer for all machines, is used as far as is practicable.

The Cell Building, on the flat, is 57 ft. wide by 280 ft. long. The cells, on the main floor, are supported on timber framework, which rests on concrete piers in the basement, and are arranged in four rows of 75 cells each. Directly under each row there are the discharge sumps and directly above are cell feed launders. All are of wood and are lead lined throughout. The operating floor is of wood.

Generator Building and Equipment.—The generator room adjoins the cell room on the south, and is 54 x 57 ft., the foundations, basement, and main floors being built entirely of concrete. The structure is of steel and gunite. All conduit has been laid in concrete floors.

Generating equipment consists of two synchronous motor generator sets, each with a rated output of 8,000 amperes at 500 volts. Two generators are direct connected to a 5,600-hp., 4,400-kva., 2,300-volt synchronous motor. Both the motor and generator fields are excited by a direct connected 125-volt, 43-kw. exciter. These sets are mounted on reinforced concrete foundations resting upon heavy concrete pads. Cooling air is passed through washers to remove any traces of acid or dust before admitting it to the generators. A 25-ton Whiting traveling crane is mounted above the sets.

Office and Laboratory.—These are up-to-date brick structures. The office is a two-story building containing the offices of the officials and the accounting and engineering staffs. Spacious reinforced concrete vaults were built for the records of the plant, and large, well-lighted rooms provide for the draughting and metallurgical accounting force.

The laboratory is exceptionally well equipped. A wet room has four large steel hoods, with hot plates and double benches for chemical analysis. Another room contains equipment for electro-analysis. The fire assay room contains two oil-fired muffles and a parting room in connection. The balance room is well lighted, and all balances are mounted on concrete piers which have no connection with the building, thus eliminating vibration. Reinforced concrete vaults are provided for sample storage. Six modern five and six-room residences have also been built for officials of the plant.

Plant Water Supply.—To insure a supply of water for solutions, electrolyte cooling, and other requirements, three wells have been sunk in the Coeur d'Alene River Valley, 1½ miles below the plant. These were dug with a crane, an orange peel bucket and considerable patience. Casing is ½-in. steel plate, 5-ft. sections, 6-ft. in diameter. Depth of wells averages 82 ft. Heavy ground made digging difficult. Water is pumped from the wells by three Byron Jackson deep-well turbines to two Byron Jackson, two-stage centrifugal, 1,500-gal. capacity booster pumps. These are driven by 200-hp. motors and pump to a 1,500,000-gal. capacity reservoir, at the plant against a discharge head of 310 ft.

The reservoir was built of reinforced concrete, cantilever type walls, 16 in. wide at the base. To allow for expansion, lead joints were placed between 50-ft. sections. Each section was poured monolithically. The floor is concrete reinforced with heavy triangular mesh wire. Slope is toward one corner, to the outlet and drain pipes. The size of the reservoir is 150 x 150 ft. x 10 ft. 6 in. deep. During the wet season a creek, which has been diverted to the reservoir by a long culvert, will supply all the water that is necessary. This can be either run into the reservoir or by-passed in a spillway built around the south and west sides. Overflow of the reservoir has been provided by lowering the level of the west wall, the water discharging into the spillway.

Domestic water supply is obtained from the creek, by a submerged dam, a pipe line being laid to domestic water tanks above the plant. Water for fire protection is pumped from these tanks to tanks on the hill near the smokestack, from which an 8-in. line distributes to fire hydrants.

Power Supply.—Power is obtained from the Washington Water Power Company's switching station at 110 kv. Two lines at 110 kv. come from the East Side substation at Spokane, while a 110-kv. line comes from the Post Falls plant. An interconnected third line at 110 kv. comes from the Montana Power Company's Thompson Falls plant, and can be used in case of a shut-down on the other two. The current is stepped down at the substation in three 110-kv. to 2,300-volt oil insulated transformers. These are protected by an oxide film lightning arrester and a 110-kv. oil circuit breaker.

Stack and Flue.—The stack is of brick, with a special acid-proof lining. It is 250 ft. high by 14 ft. inside diameter at the top. Being placed on a hilltop some 232 ft. above the plant, it will carry the gases high into the upper air strata. The foundation is reinforced concrete. The flue is all steel, ¼-in. plate, of the balloon type, 10 ft. wide by 1,152 ft. long. Cleanout doors are placed every 4½ ft.

Dust Recovery.—Considerable dust is carried in the roaster gases, due to the fineness of the feed. This is recovered in the Cottrell plant, which is situated at the base of the stack. It is the plate and wire type of precipitator, consisting of two units of five sections each. Four sections of each unit are installed for treating, electrodes being omitted from the third section. This arrangement has been found to give highly efficient treatment of the gases. Collecting electrodes are of corrugated iron, and the discharge electrodes of black iron wire, spaced at 4-in. centers. The electrical equipment consists of two a. c., 15-kva., single phase, 60-cycle transformers, with a 400-volt primary and a 60,000-volt secondary, with reduced capacity taps, and two mechanical disk rectifiers driven by synchronous motors at 1,800 r. p. m.

With the foregoing summary of the plant's construction, a few words on the equipment and operation will be added. Lack of time and space forbids mention of the various details, but the writers will try to give a general idea of the plant installation and its workings.

Personnel

Wallace G. Woolf, metallurgical engineer, who for years has been supervising the experimental work at the North Mill pilot plant, has assumed the superintendence of the plant. E. R. Crutcher is assistant superintendent and S. R. Zimmerly is metallurgist. A. B. Wadsley is chief chemist and head of the assay laboratory, while A. V. Dunkle is chief electrician.

The foremen of the plant have been selected from the men who have assisted in the experimental work and building. The wisdom of this course has been demonstrated by the remarkably successful beginnings of each successive operation.

Plant Equipment and Operation

FIVE 270-ton capacity reinforced concrete bins receive the concentrates from the cars. At the normal rate of feed this is a 10-day supply for the roasters. A system of belt conveyors, with a weightometer and bucket elevator,

carry the feed to roaster feed hoppers, which feed five 25-ft., 8-hearth Wedge roasters, each having a nominal capacity of 40 tons per 24 hours. Rabble arms, of which there are two to each hearth, are air cooled, the air thus heated being discharged into the atmosphere or onto the hearth for roasting. This last feature, which seems particularly worthy of note here, is accomplished by fitting a 3-in. pipe, with a three-way valve to the air discharge pipe of the rabble arms, and through the central shaft so that it extends out over the hearth. At 45 deg. from the perpendicular ⅝-in. holes are drilled in the pipe. Preheated air is thus admitted to the roast in controlled quantities and in such a way that it breaks up the blanket of SO_2 lying over the bed, giving more contact of oxygen with the roasting particles, and a more efficient roast, without at the same time cooling the gases in the furnace. Where oxidation is particularly rapid, air can be diminished, if necessary, to hold the temperature to the desired point. A multiple electric recording pyrometer, with a thermocouple on each hearth, serves to check the temperatures at all times. Furnaces are auxiliary oil fired on the seventh hearth.

A 14-in. Jacoby conveyor is used to convey the calcines from the roasters. This conveyor is the rotary type fixed internal spiral, which, due to its rotary motion, has large radiation losses. It thus becomes a cooler as well as a dust-proof conveyor. Screening of the calcines is at 20-mesh on a Leahy vibrating screen, the oversize being crushed and re-roasted, the undersize passing to two Dings-Wetherill magnetic separators by means of screw conveyors. The magnetic zinc ferrite and the non-magnetic zinc oxide products go into five reinforced concrete bins of 100 tons capacity each. All calcine handling conveyors and feeders are enclosed to prevent dusting. A dust collector has been installed and pipes connected to all dusty points.

The Leach.—Leaching is accomplished in three 20-ft. by 13-ft. woodstave, lead-lined agitator tanks. The agitator consists of a central vertical shaft supporting an arm radially, from which is suspended eight lead covered fingers. Each agitator shaft is driven by an individual motor, power being transmitted through a James speed reducer and a bevel gear. Solutions are heated by lead steam coils.

The zinc ferrite is first added to a 28 to 30 percent sulphuric acid solution, and is dissolved. When the acidity approaches 15 percent the more soluble oxide and sulphate is added, and the leach brought to neutrality. Manganese dioxide is added to oxidize the iron so that it will precipitate out as ferric hydrate as the leach is neutralized.

Six Burt filters take the leached pulp from a surge tank. These filters are the rotary internal pressure type, 4 ft. 6 in. inside diameter by 40 ft. long. They are especially adapted to the filtration of a gelatinous pulp, and wash the zinc sulphate from the cake with a minimum of wash water. The filtrate discharges into a sump, from which it is pumped to solution storage tanks, ready for purification. The residue is thickened, filtered, and dried, and sent to the smelter for the recovery of the lead and silver.

Purification.— The filtrate containing the impurities cobalt, copper, and cadmium are drawn from the storage tanks to purification tanks. These are 22 ft. in diameter and 15 ft. in height, wood stave, and lead-lined, with lead pipe steam coils for heating. Agitation is mechanical as in the leach tanks. When the solution temperature is right zinc dust is added and agitation continued until the impurities are brought down. Purified solution is then filtered in 36 by 36-in. Shriver pressure filter presses, and discharged into two 30-ft. diameter check tanks. If sufficiently low in impurities, it is ready for the cells. Careful check is made at all times to insure pure solutions. Operators are given simple tests with which to determine the progress of the purifying, and the final sample is sent to the assay office for check analysis, before release to the cells.

Electrolytic Department.—A lead-lined launder carries the neutral solution from neutral storage tanks to the cell circuit, while a pipe line carries back to the electrolyte storage tanks a similar amount of spent electrolyte. For this purpose a steel bridge was built from the tank floor of the main building to the cooling rooms across the tracks. This bridge is completely enclosed, with gunite walls.

Electrolyte circulates continuously from the cells to a 42-ft. lead-lined balance tank. From here it is pumped by Antiseli type lead-lined pumps to five cooling cells in which are immersed lead cooling coils connected in parallel to the water supply line from the reservoir. Circulating about these coils, electrolyte is cooled to the working temperature of the electrolytic cells, and passed on to the cell feed launders. When the acid regenerated in the cells approaches 28 percent and the zinc content has decreased to about 10 percent, neutral solution containing about 220 grams of zinc per liter is drawn from the neutral storage tanks, and added to the balance tank revitalizing the spent electrolyte: and at the same time, as mentioned above, a similar amount of spent electrolyte is pumped back to electrolyte storage tanks and used in the leach.

Cells are fed individually through hard rubber pipes from the overhead feed launders, and discharged individually through a hard rubber overflow pipe to sumps below. In case of trouble the entire load can be dropped in a few minutes. Each cell contains 20 lead alloy anodes and 10 sheet aluminum cathodes, or two anodes per cathode. The cathode header bar is copper plated at the contact and slips into a copper clip on the bus bar, making a good connection. The anode is cast in the shape of a grid to permit better circulation of the electrolyte between anode and cathode, resulting in higher current efficiency.

The cells in each unit are electrically connected in series to the 8,000-ampere, 500-volt motor generator set. The cathodes of each cell are connected in parallel. Thus there is a flow of 800 amperes per cathode, or about 100 amperes current density per square foot of cathode surface.

The cathode melting furnace is a small reverberatory, 15 ft. wide by 28 ft. long, the hearth and arch being built on a 50-ft. radius curve, with a slope toward the ladling wells. Charging is through a swinging door at the top. At the flue end of the furnace, built into the hearth, are two wells, with inlet from the bath at the bottom. Zinc is ladled from the wells in two steel plate ladles suspended from a trolley. The mold racks are under, and to one side of the trolley beams. Pouring is by hand, each slab weighing approximately 60 lbs.

Zinc Dust Plant.—Zinc dust for purification is blown by subjecting a slender stream of molten zinc to a high pressure air jet. Molten zinc is ladled from the melting furnace into a graphite crucible zinc dust furnace. Expanding air as well as the high pressure from the V-shaped jet pulverizes the zinc in the stream to between 50 and 60 percent through 200 mesh.

Product.—Before the Sullivan Mining Co. began marketing its product, branded Bunker Hill zinc, it was impossible to obtain 99.99+ pure zinc in commercial quantities. Every carload sold since production started from this plant has assayed better than 99.99 percent pure, and the extreme variation for all shipments has been less than five thousandths of 1 percent. The average assay of a normal month's production is:

Cadmium	.001%
Lead	.002%
Iron	.002%
Copper	.001%
Tin	none
Aluminum	none
Zinc by difference	99.994%

Twenty-eight months of continuous production, during which a daily analysis of each lot was made, has proven that this grade of zinc can be produced under the careful metallurgical control of the plant staff, in all weather and under all operating conditions. This uniformity of high grade product is a very important factor to consumers of this grade of zinc, to whom included impurities in the metal mean increased cost in the production of manufactured articles.

Some of the advantages of 99.99+ percent zinc are, approximately 30 percent greater ductility than that of the high grade brands known to the industry before it was produced, higher corrosion resistance, elimination of hot-shortness, to a large extent, in the die-casting trade, thus decreasing cracking upon removal from molds, and greater tensile strength.

Uses.—The high grade zinc produced at this plant is used largely for die-castings. Many new applications of this trade to produce appliances from zinc alloys for use in automobiles, office supplies, home appliances as well as in the electrical and radio fields, have been developed in recent years. By using alloys of aluminum and copper with high grade zinc, die castings can be turned out that do not require machining, thus making possible the production of large numbers of parts of identical dimensions, insuring interchangeability, and having a finished surface.

Marketing.—Bunker Hill zinc is sold through the St. Joseph Lead Company, the largest lead-producing company in this country, which has been marketing non-ferrous metals for more than 70 years.

Electrolytic Cadmium Plant

CADMIUM occurs as an impurity in practically all zinc ores. The quantity present is very small and rarely exceeds a few tenths of 1 percent. This ma-

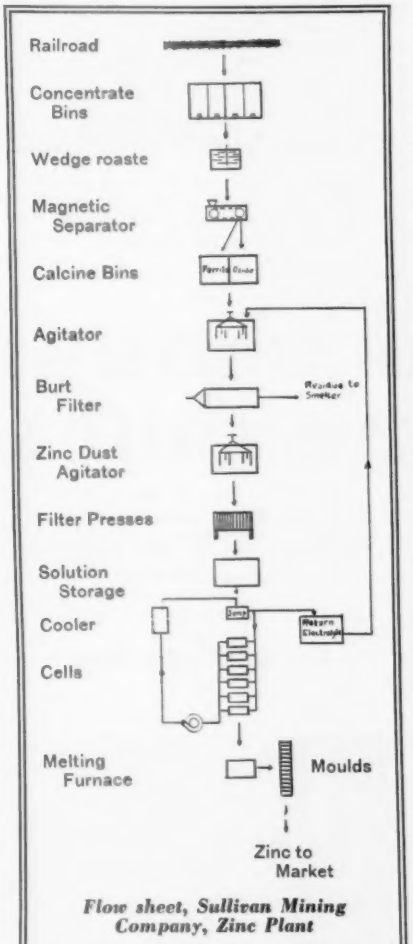
terial is objectionable in electrolytic zinc and its removal from the zinc plant solutions is an expensive but essential part of the process. The removal of cadmium is accomplished by treating the zinc bearing solutions with finely divided zinc dust. This action removes the cadmium together with other impurities, chiefly copper, nickel and cobalt as a finely divided metallic material known as "purification residue." The residue also contains about 40 percent zinc, which is recovered and again returned to the zinc plant after the cadmium and other impurities have been removed. Thus the cadmium plant performs an additional function, namely, the salvaging of zinc from a form in which it has no commercial value. This residue, in which the cadmium has been concentrated about 100 fold, constitutes the feed to the cadmium plant.

The residue is carried by a conveyor from the storage pile to the cadmium plant, where it is fed into a ball mill. The sludge from the mill goes into a lead-lined leach tank, where it is agitated with 27 percent sulphuric acid, spent electrolyte from the zinc plant. The cadmium is dissolved and the copper remains in the form of cement copper. The copper is eliminated here as a high grade product that is shipped to a copper smelter.

The solution carrying the cadmium is passed over zinc plates, where the cadmium is precipitated as a metal sponge. The sponge floats to the surface of the boxes and is scraped into a launder which carries it to a Burt filter, where the solution is filtered off and the sponge is washed. This sponge is contaminated with zinc, nickel, cobalt, lead and iron and must be redissolved and electrolysed to produce commercial cadmium. The solution, after passing through the boxes, is barren of cadmium but is rich in zinc; the purification stage will be taken up later. An overhead crane, running from above the precipitation boxes directly over the railroad siding, expedites the handling of the zinc plates, which are consumed quite rapidly during the process.

The sponge, after washing, is stored for some time to permit it to become partially oxidized. The oxidized sponge dissolves very readily in the return electrolyte from the cadmium cells. All of the cadmium is not oxidized and this remaining metallic portion serves to remove small quantities of copper which may have gotten past the leach, and it also tends to keep other impurities from building up to the full extent in the solution. After being dissolved, the cadmium in the form of neutral solution is sent to the storage tank and is ready for electrolysis. The cells are of the stationary cathode type and are in most respects similar to the standard cells used in the zinc plant. The chief points of difference are, the cell reagents and the use of a lower voltage and much lower current density in the cadmium cells. After electrolysis, the spent electrolyte is returned to the re-solution tank, where the acid generated during electrolysis is used to dissolve cadmium sponge and is again returned to the cells as neutral solution. Although the electrolysis is not very sensitive to impurities, after these have built up for some time it is advisable to discard a part of the solution. This foul solution can be practically depleted of cadmium by passing it through a stripping cell before it is finally discarded. The cathode cadmium is produced in a high degree of purity.

The purification of the heavy zinc solution coming from the zinc boxes constitutes one of the innovations in the present plant. This solution contains cobalt (a very objectionable impurity in zinc plant electrolysis) the greater part of which must be removed before the solution is returned to the main zinc plant circuit. This removal is accomplished by means of an additional purification process.



Flow sheet, Sullivan Mining Company, Zinc Plant

The melting of the cathode cadmium is carried on under a cover of fused caustic soda or heavy gravity oil. The metal oxidizes at high temperatures and the bath is necessary to prevent excessive drossing of the metal. The molten cadmium is cast into shapes required by the market, pencils, balls, slabs or anodes.

The tanks throughout the plant are lead-lined and equipped with steam coils to permit temperature control of the solutions at any stage of the process. A motor-generator set supplies the cadmium plant with its own source of direct current independent of the zinc plant generators. The entire cadmium plant is so arranged that any unit can be temporarily shut down without affecting the operation of the rest of the process. In general it resembles the zinc unit on a smaller scale and embodies the features of design indicated by the experience with the electrolytic zinc plant.

A very pure grade of cadmium is produced, it being a worthy companion of "Bunker Hill 99.99+ percent Zinc," the product also of the Sullivan Mining Company and which is being well received by the trade as its superior quality is becoming recognized.

Uses of Cadmium

CADMIUM is a constituent of nearly all of the well-known alloys employed in fusible plugs for automatic sprinklers, steam boilers, and fire alarms, and for safety fuses in electric circuits, says Paul M. Tyler in a report recently published by the United States Bureau of Mines, Department of Commerce. In addition to cadmium, these mixtures usually contain lead, tin and bismuth. By varying the relative proportions of the different constituents, alloys with a wide range of melting points can be produced. Lipowitz's metal, a white metal with a luster like that of polished silver, which melts at 60 deg. centigrade, is used for making casts of small animals and insects and forms an especially good solder for Britannia metal. A similar alloy is used for making casts of parts of the human body. Wood's metal, which is even better known, melts at a slightly higher temperature (71 deg. centigrade). There are quite a number of these multiple alloys that melt at temperatures below the boiling point of water; several of them are moderately strong and can be bent or worked in a lathe. An antimony-lead alloy containing bismuth and cadmium has been invented for bonding glass.

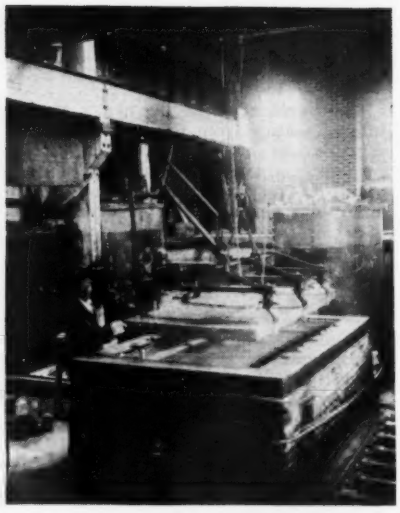
Cadmium formerly entered largely into dental alloys. A common dental amalgam consisted of 26 percent of cadmium and 74 percent of mercury—tin and bismuth often being added to the mixture—but this amalgam discolors the dentine more than other mixtures subsequently developed and has been largely discontinued. Cliche metal for stereotype plates may be made with about 22.5 percent of cadmium, 50 percent of lead, and 27.5 percent of tin, a mixture superior to the corresponding cliche metal containing bismuth, as it gives a greater number of impressions.

An important use of the metal is in copper telephone and trolley wires. In proportions of .5 to 1.2 percent cadmium raises the annealing temperature and adds materially to the strength and wearing qualities of copper without greatly reducing the conductivity, as practically all other hardening agents do. Some quantities of cadmium are used to improve the properties of both plated and sterling silverware. In the jewelry trade cadmium is employed for producing green gold.

A new use for cadmium, which because of its connection with the automobile industry has become of great importance, is in rust-proofing steel, particularly nuts, bolts, sundry small parts of automobile, and various light hardware, including locks, refrigerator trimmings and certain wire products.

Cadmium has been employed in the form of wire for coating or "metal spraying" plaster (*Continued on page* 640)

BUNKER HILL & SULLIVAN MINING AND CONCENTRATING COMPANY



Chemical lead slab pan with finished slab being lifted to place under the mill. The charging pot is shown just behind the slab pan.

THE NORTHWEST LEAD COMPANY

Subsidiary of Bunker Hill & Sullivan Mining and Concentrating Company

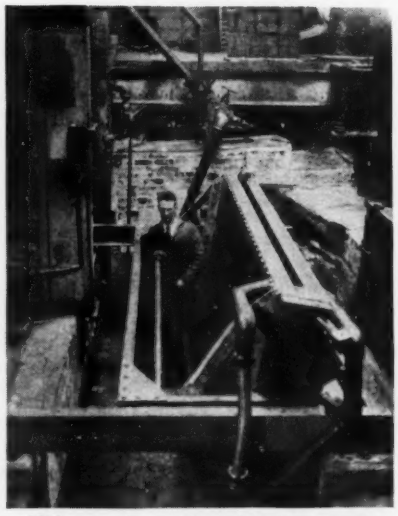
By J. W. Gwinn

THE Northwestern Lead Company (owned 70 percent by the Bunker Hill and Sullivan M. & C. Co.—the balance largely by employes) is located at Seattle, Wash. Its officers are: Frank M. Smith, president; Roger H. Cutting, vice president and manager; J. A. McDonald, vice president and plant superintendent; John R. Owen, secretary and Northwest sales manager.

This plant concerns itself with the manufacturing of pure lead products, antimonial pipe and sheet lead, and lead specialties. No solders, babbits, or mixed metals of any kind are produced. From 3,500 to 4,500 tons of lead are manufactured each year and sold to plumbing jobbers, metallurgical plants, paper mills, chemical plants, and allied industries. Prompt service is given to all users in Montana, Utah, Arizona, and Pacific coast states, as well as trans-Pacific accounts in China, Japan, Hawaii, and the Philippine Islands.

Raw materials are Bunker Hill 99.99 percent pig lead, Wah Chang Circle Brand antimony, and a small amount of pure copper for special sheet and pipe alloy specifications. Carload incoming and outbound rail shipments are handled conveniently on our own spur track at the rear of the plant. Water and L. C. L. rail shipments are trucked to and from the docks and depots.

The sheet-lead department is equipped with one of the most efficient mills and slab-casting units in the country. For chemical sheets a 5½-ton slab is cast in a special oil-heated horizontal pan. Bunker Hill pig lead is melted in an oil-fired 10-ton pot and the slab pan is preheated uniformly. The molten lead is run in and thoroughly skimmed to remove all dross. The casting pan burner is then shut off and a special fan drives a current of air under the casting pan to more rapidly cool the slab. As soon as the slab is solid, a crane with a special frame picks it up and moves it to the mill for breaking down. Each pure-lead slab is 4 ft. 6 in. wide, 9 ft. long, 5½ in. thick, and weighs 5½ tons. Antimonial sheet-lead slabs are cast in a vertical pan designed and patented by the Northwest Lead Company.



Slab pan for antimonial sheet lead. Note vertical construction, line for oil bath to both heat pan and chill the slab as soon as it is poured and drossed.

In producing antimonial sheet lead, the specified antimonial-lead alloy is mixed in the melting pot. Care is taken that the temperature of the alloy does not rise much above the melting point of the mixture. The casting mold is preheated—by means of controlled temperature—to approximately the temperature of molten lead. The slab is poured and drossed, and extreme care is taken in controlling the rapidity of its solidification. The Northwest lead plant makes an exceptionally large recovery on all antimonial sheet-lead slabs.

As soon as the antimonial slab is solidified it is removed from the mold and immediately placed on the mill for breaking down. The antimonial slab is 4 ft. 6 in. wide, 9 ft. long, 2½ in. thick, and weighs 3 tons. Temperatures are under control at all times, through potentiometer readings, and are varied to meet changing conditions.

Both chemical and antimonial lead slabs, when placed on the mill for breaking down, are rolled to about three-quarters of an inch in thickness and are then cut to the necessary size to make the specified sheet. The mill is electrically driven and controlled throughout. One operator handles the controls, working a series of levers and buttons which govern the live bed rolls and the cutting mechanism. Two men take the completed sheets at the finishing end of the mill, square them, and roll them on an electrically driven mandrel. They are then run onto special trucks for slatting and go to stock or order, as the case might be. Raw materials are received at the rear of the plant, are cast, milled, and packed ready for shipping when taken off the front of the mill table.

Pure sheet lead is furnished in sizes from 1 lb. to 60 lbs. per square foot, and from 8 to 9 ft. wide and up to 55 ft. long. Antimonial sheets are supplied in antimony percentages from 1 to 10 percent and in sizes as specified by the customer.

The lead-pipe department operates two presses. They are of the vertical type, with the hydraulic ram below the floor level. The cylinder is fastened to the head of the ram; the cores are centered in the cylinder; and the dies, with their respective nozzles, bolt to the press head above. Each press is equipped with a melting pot for charging the cylinders. This permits operating one press on antimonial lead and the other on pure lead, if desired. The smaller press manufactures small sizes of pipe, up to 6 in.; the larger press produces all sizes up to 12 in., and is particularly used for antimonial pipe, as it operates on pressures up to 1,000 tons. Cores and dies are made by our own toolmakers, using a special heat-resisting steel. This guarantees that cores and dies will not warp or lose temper in service.

Bunker Hill 99.99 percent pig lead and Wah Chang Circle Brand antimony are used exclusively in the pipe department. Two operators are required for each press. One is responsible for keeping the pots charged and takes away the pipe as it extrudes from the press; the other charges the press cylinder, quenches the charge to solidify it, and operates the ram valves. The second man is held responsible for the quantity and quality of the production.

The most unusual equipment in the pipe department is the result of Northwest Lead Company's own development, and is patented. Each press is equipped with automatic cut-off saws, designed to cut the pipe to any specified length as extruded. The mechanism consists of a motor-driven circular saw which travels in a horizontal plane. As the pipe extrudes vertically to the desired length, whether 15 in. or 12 ft., an electrical contact is made, the motor starts, and the saw swings over and cuts the pipe cleanly and squarely. As the cut is finished, the motor shuts off and the saw swings back out of the way until the next contact is made, when the operation is repeated. This device is a large time and labor saver and speeds production at least 25 percent.

The press equipment produces over 225 pipe sizes, ranging from the smallest tubing to 12-in. inside diameter, with ¾-in. wall material. We also manufacture lead wire, came lead, strip lead, and specialties such as the lead sheathing for a patented "Steelead" skylight bar. These are all produced from the lead presses.

Plumbing fittings, such as S traps, P traps, bends, ferrules, and combination bends and ferrules, drum traps and other drainage specialties for the plumber, constitute another line produced by special machines. The trap machine on which most of the above are produced operates on the same principle as the pipe press, with one or two exceptions. It is equipped with two cylinders for holding the lead charge, and two hydraulic rams. These are on a horizontal plane, and the discharge is into a combination die which produces vertically. The ram pressures are controlled by a lever which causes the pressure from both rams to be uniform when held in neutral; a shift of the lever forward or backward causes greater pressure from the right or left-hand valve as needed. The varying pressures cause more lead to flow through the die from one side or the other, and this results in the bend, made to any form desired by the operator. The trap machine is equipped with its own melting pot for charging the cylinders, with an automatic cut-off saw similar to those on the pipe presses, and with a gas nozzle to keep the die hot enough to prevent plugging.

All plumbers' fittings are of pure lead, and are produced as outlined above, excepting drum traps. These are made from pure lead pipe and the end is closed by spinning on a specially designed lathe. The clean-out feature of our fittings is worthy of attention. The brass rings and screw cap were designed and are manufactured by us. They are made so that the cap, when in place, fits flush with the inside of the trap, and eliminates the danger of clogging. The rings are sweated into place so that a smooth contact is made at all points, and the soldering is the full depth of the ring and thickness of the trap wall, and a tight, solid job is the result. Drum trap covers and rings are similarly handled.

Bunker Hill brand lead wool may be compared in some respects to steel or glass wool, in that it is made up of thousands of very fine strands of lead formed into a loose rope-like product. Lead wool is used for calking underwater joints in water, gas and oil lines, and in all places where a poured joint is difficult or impossible; such as in plugging water out of an oil well. This material must be produced from the very purest lead to give the best service.

The lead-wool equipment consists of a long, narrow, gas-fired and insulated melting pot, mounted on a platform about 12 ft. above the floor level. The pot is mounted at an angle of about 60°. The lower end of the pot is equipped with a nozzle and special steel die, punched with hundreds of holes as small as a pin point. The melted lead is held at approximately 700° F. The weight of the column of molten lead forces it out through the tiny holes of the die plate in very fine threads, which immediately solidify on striking the air. These are caught in a large tin-lined V-shaped trough on the floor below and slide to the bottom of the V. Here two beater arms compress the mass to loose rope form, and the finished product is bagged or spooled for shipment.

A considerable proportion of this plant's productions features consist of special equipment for pulp and paper mills, chemical plants, smelters, and reduction works. Equipment of this nature is built to specification. The casting department manufactures lead bends, tees, spiders, and other fittings for handling hot solutions where extruded pipe will not stand the pressures or temperatures. These castings are usually of antimonial lead.

We manufacture all sizes and types of lead-lined pipe and fittings, from the small sizes up to 24-in. All sizes up to and including 12-in. are lined with seamless pipe. Cast fittings and pipe are carefully sealed and cleaned, and the lining is run into the pipe from the press or formed by beating into the fittings. The ends are flanged and dressed and the maximum hydraulic pressure that the steel or iron will stand is then pumped into the pipe or fittings. This expands the lead lining uniformly into every spot in the pipe or fitting and gives a bond that will last the life of the lining.

Many of our contracts are for lead roofs and special equipment. Contracts specify, as a rule, unusual weight antimonial lead pipe and sheet lead for heating or cooling coils, agitators, small electrolytic tanks, etc. The material is produced to specification and our lead burners make up the units. We also take outside contracts for large jobs where we not only manufacture the pipe and sheet but install the complete job. This sort of work has been done for pulp and paper mills, chemical plants, smelters, and refiners. Our contracting department will take a complete installation, assuming all responsibility for material and workmanship. We have just completed an antimonial lead roof on the beautiful Grace Cathedral, at San Francisco, and a similar lead roof on the Cathedral of St. John the Evangelist, at Spokane.

In the past few years American architects have been giving very favorable consideration to the employment of lead in the home, as well as in industrial construction. The application of lead to this kind of work is rapidly becoming popular and is seen in beautiful lead rain leaders, ornamental panels, cast figures for house or garden, as well as for roof work and flashings. The Northwest Lead Company is constantly called upon to do this intricate work and is equipped to produce any lead shapes, forms, or designs that may be desired.

We also manufacture a patented skylight bar, called "Steelead." On a standard 1½ x 1½ x 3/16 in. or 2½ x 3 x 3/16 in. steel T bar is drawn a seamless sheath of pure lead. After the steel bars and the sheathing are cut to proper length the bars are encased in the sleeves and the ends of the sleeves are burned with lead. No particle of steel is exposed to the air. In addition to sealing the steel with an impervious jacket, the sheath is so shaped as to be a perfect support and grip for the skylight glass. This is the patented design for skylight construction. Our skylights give exceptionally satisfactory service in class "A" buildings, or for chemical or power plant jobs. Many "Steelead" installations have been made on buildings where large glass areas are needed, such as auditoriums and gymnasiums. We manufacture the complete job to the specifications of our engineers and the architect, and will install or place the installation with a reliable firm subject to our inspection and supervision.

The results of electrical resistivity and electrical induction measurements at Abana Mine, Quebec, Canada, have been published by the United States Bureau of Mines, as Technical Paper 501, by E. Vernon Potter. This paper forms the latest contribution to a series devoted to geophysical prospecting.

The ore body studied is an intimate mixture of chalcopyrite, sphalerite, and pyrite, with fractional percentages of galena and tetrahedrite. The gold and silver are associated with copper, zinc, and lead minerals. The pyrite contains no precious metals.

In making these tests, it was the aim of the geophysical section of the Bureau to determine experimentally to what extent the megger earth-resistance tester would be applicable in locating the mineralization in this district.

The paper also contains an "Explanation of some factors associated with the induction method," by F. W. Lee.

Safety first sign prominently displayed in the Kellogg Tunnel, about 2 miles from the portal, where all miners can see it on their way to their work

INDUSTRIAL WELFARE

By J. W. Gwinn

Solarium

IN 1929 the Bunker Hill & Sullivan Mining & Concentrating Company installed an automatic solarium, or artificial sunlight machine, capable of treating 300 to 350 cases per hour, supplied by the Burdick Corporation, of Milton, Wis., the purpose of which is to provide a substitute for sunshine for underground and office workers. A seven-year experiment was made with one ultra-violet lamp in the company's industrial hospital, principally on pathological cases, but to some extent on cases of anaemia, malnutrition and general run-down condition, and the favorable results from this period of investigation led to the investment in the solarium. It consists of a cabinet 100 in. wide and 12 ft. long and 109¾ in. high, in which six quartz-mercury arc lamps supply the ultra-violet rays. A moving platform carries the recipient of the treatment through the cabinet at a speed which can be regulated to the requirements and accurately maintained. The usual speed of the belt is 12 ft. per minute, for adults.

By installing the solarium as an adjunct of the change house, it is very conveniently located for the miners, who step from their shower bath to the moving platform, and without much loss of time, receive their sunshine before dressing.

The privileges of the solarium are extended to the families of employes, under the immediate supervision of the industrial nurse, at certain hours during the day, and a great many mothers take advantage of the opportunity for themselves and children under school age. It is also available to all school children, for which the school board supplies bus transportation from schools situated beyond easy walking distance, during certain periods of specified days. During the summer months, when there is more natural sunshine available, the solarium is not operated. During 1930 the average number of persons receiving treatment each month was 688, divided as follows: Employes, 292; women and girls, 318; school boys, 78, representing a total number of treatments per month of 3,845.

It is difficult to determine just what benefits have been derived by those persons taking the treatments, but it is the opinion of the hospital staff that resistance to colds, disease, and a decrease in rundown conditions are greater among those who have consistently taken the treatments. An example which may be cited, but which is not necessarily conclusive, is the record of pneumonia cases among employes during 1930. Of the total number of these cases, 37.5 percent had taken sunshine treatments and 66.6 percent of these patients recovered, whereas the total fatality was 62.5 percent. In another case, a girl gained 17 pounds in weight during a period of one year, where her normal yearly gain previous to taking treatments was about 1 pound.

Hospital

The company hospital, built and occupied in July, 1908, is under the direct supervision of Dr. Geo. H. Kennett, the company physician and surgeon. Payment by employes of $1 per month hospital fee entitles them to all the necessary medical and surgical treatment in case of sickness or injury. The hospital has a staff of four to five graduate nurses, and is equipped with modern surgical equipment, among which may be mentioned diathermy and oxygen tanks for treatment of pneumonia, infra-red lamps for muscular soreness, and X-ray for pictures and certain skin ailments.

Individual card records are kept in the hospital for each employe who calls at the hospital for minor injuries or consultation, on which are recorded diagnosis and treatments given. This record is important, not only to the hospital as a history of the case, but as a record of the frequency of calls from the individual. They also provide records from which the industrial nurse can check up cases reported to her. The following information, taken from these cards, covers a period of one year:

Number of individual employes calling at hospital		2,136
Treatments given	Number	% of total
Dressings	3,907	38.99
Medicine	3,772	37.65
Eyes	775	7.75
Infra-red	653	6.53
Consultation	427	4.28
Surgery (sutures, etc.)	175	1.76
X-ray	116	1.18
Ear	107	1.08
Ultra violet	77	.78
Diathermy	10	.00—
Serum	3	.00—
Fractures	2	.00—
	10,024	
Average number of calls per person		4.69
Average number of calls per day		27.46

The foregoing figures do not include major accidents or sickness requiring hospitalization.

The average number of lost-time accidents is about 156 per year in all departments, of which number 75 percent are compensable, but less than 25 percent require hospitalization for a period of 10 days, and less than 2 percent are fatalities. It is estimated that illness causes twice as much lost time as do accidents.

The greatest source of accidents underground is in the use of tools and the handling of timbers, and from falling ground, especially small boulders dropping from the back of the stope near the collar of the drill hole, while the drill is in operation, resulting in crushed fingers and toes and head lacerations. Another source of injury is the breaking of the drill steel while the drill is in operation, due to the sudden and unexpected erratic movements of the stoping drill, out of control of the operator. Accidents among employes working on the surface are largely due to improper handling of tools and materials.

On June 1, 1929, Mrs. H. R. McBride, a graduate nurse, joined the hospital staff as industrial nurse. Her principal duty is that of visiting and assisting all employes and their families incapacitated by illness or accident from any cause whatever, and to see that they are properly cared for and receive the necessary medical attention and hospitalization when necessary. To facilitate this work, reports are made each morning by the foremen of all departments, naming all men absent from work the preceding day. These cases are then investigated by the industrial nurse. During 1930 there were 561 men reported off duty in all departments, which resulted in 788 calls being made on the men and 931 calls on women and children of their families. Beside the benefits derived by the employe from these visits, many instances arise whereby the nurse can inform the parents of needed medical attention for pre-school children, which would otherwise escape their attention.

The accompanying tabulation gives the results of a recent census taken of all employes.

Fire fighting helmet crew, Bunker Hill Mine

INDUSTRIAL Y. M. C. A.

Because of the absence of any community club house or recreational center, business men of Kellogg purchased and donated ground on which, in 1911, the Bunker Hill & Sullivan Mining & Concentrating Co. erected a two-story brick building, the lower floor of which was donated for the use of the Y. M. C. A. as a community center for recreational and education purposes. A board of directors composed of residents of the community direct the policies of the local organization, while the active administrative duties are performed by Raymond D. Wilder, Y. M. C. A. secretary, and his staff of assistants. Membership is open to all the people of the community, upon payment of monthly dues of $1.

Advantages offered are a gymnasium, plunge, shower baths, reading rooms containing all the current magazines and newspapers, committee rooms, bowling alleys, and pool and billiard tables. During the winter months classes are conducted in public speaking, shorthand, typewriting, bookkeeping, English for foreigners, advanced English literature, journalism, all branches of mathematics, mechanical drawing, radio and electricity, salesmanship, and citizenship.

Athletic leagues are formed among the business houses of the city and among the different departments of the mine, mills, smelter and zinc plant, which stage inter-league contests in basketball, bowling, handball, volley ball, indoor and outdoor baseball, and swimming. Junior leagues are also formed among the school children of the city, and leagues among the ladies of the community afford competitive contests in swimming and bowling.

FIRST-AID AND MINE-RESCUE WORK

The several mining companies in the district cooperate in the maintenance of a central mine rescue station, in the district, under the supervision of Hugh McDermott, director. Classes are held at each of the participating mines, in which instruction is given in first-aid work. These classes have a membership of from 150 to 225, and by holding a series of classes throughout the year a large percentage of the employes receive the instruction. There is a marked improvement in the condition of injuries reach-

EMPLOYE CENSUS—ALL DEPARTMENTS—JANUARY 1, 1931

Nationality	Number	Percent of Total	Average Age	Married Number	Married Percent	Citizens Number	Citizens Percent	First Papers Number	First Papers Percent	Homeowners Number	Homeowners Percent	Average Years Service
American	820	63.96	35.94	590	71.95	820	100.00	..	.....	233	28.41	4.34
English	59	4.60	46.88	51	86.44	37	62.71	12	20.33	25	42.37	9.30
Italian	53	4.13	37.49	40	75.47	25	47.16	7	13.20	23	43.39	7.92
Swedish	38	2.96	40.10	26	68.42	27	71.05	..	.....	9	23.68	6.09
Canadian	35	2.73	33.80	23	65.71	7	20.00	6	17.14	12	34.28	2.80
German	35	2.73	40.17	18	51.42	27	77.14	..	.....	9	25.71	4.36
Irish	33	2.57	39.78	19	57.57	30	90.90	1	3.03	4	12.12	4.65
Jugo-Slavia	29	2.26	41.00	14	48.27	12	41.37	3	10.34	7	24.13	6.35
Norway	29	2.26	41.62	20	68.96	18	62.06	3	10.34	8	27.58	7.66
Austria	23	1.79	38.52	10	43.47	11	47.82	3	13.04	5	21.73	4.09
Welsh	21	1.63	45.61	10	47.61	15	71.42	1	4.76	7	33.33	11.14
Mexican	19	1.48	27.31	5	26.31	..	.....	1	5.26	..	.....	1.42
Scotch	15	1.17	45.60	12	80.00	13	86.66	2	13.33	9	60.00	10.01
Greek	12	.94	35.91	3	25.00	3	25.00	4	33.33	1	8.33	6.67
Finland	12	.94	43.83	5	41.66	6	50.00	1	8.33	2	16.66	2.40
Serbia	8	.63	42.37	4	50.00	..	.....	2	25.00	..	.....	9.63
Poland	7	.55	40.57	4	57.14	2	28.57	..	.....	1	14.28	3.23
Holland	7	.55	34.71	4	57.14	5	71.42	1	14.28	3	42.84	4.33
Russia	5	.39	40.00	2	40.00	..	.....	2	40.00	1	20.00	3.39
Switzerland	4	.32	43.75	1	25.00	2	50.00	1	25.00	2	50.00	7.70
Denmark	3	.24	34.00	1	33.33	1	33.33	..	.....	..	.....	3.49
France	3	.24	29.66	1	33.33	2	66.66	..	.....	1	33.33	3.38
Bulgaria	3	.24	35.33	1	33.33	..	.....	1	33.33	..	.....	.72
Roumania	2	.15	47.50	1	50.00	1	50.00	..	.....	1	50.00	8.29
Czecho-Slovakia	2	.15	56.00	1	50.00	1	50.00	1	50.00	..	.....	5.16
New Foundland	2	.15	42.50	1	50.00	..	.....	..	.....	1	50.00	3.75
Spain	1	.08	43.00	1	100.00	1	100.00	..	.....	..	.....	.08
Belgium	1	.08	41.00	..	.....	..	.....	..	.....	..	.....	1.50
Esthonia	1	.08	20.00	..	.....	1	100.00	..	.....	..	.....	.75
29	1,282		37.42	868	67.7	1,067	83.22	52	4.05	364	28.39	5.02

ing the hospital now over conditions that existed before the first-aid work was undertaken, and the number of infections has materially decreased, due to the prompt care received by an injured employe on the job.

In addition to first-aid work, instruction is given in mine-rescue work, which includes fire fighting and work in smoke-filled areas. Training is given in the use of helmets or gas masks, to picked crews of men, and in the care of the equipment. A special building is provided for these classes, where the equipment is always available, and where smoke or gas filled rooms provide facilities for training under conditions similar to those that would be encoutered in an underground fire.

WORKMEN'S COMPENSATION

By H. R. McBride*

THE experience of this company under the Workmen's Compensation Law is probably not very different from others in the same business.

Under the Idaho statute the employer has choice of three plans, viz, State Insurance Fund, casualty company policies, or self-insurance. The Bunker Hill operates under the latter provision.

To become a self-insurer the law requires that the employer deposit and maintain with the Industrial Accident Board security satisfactory to the board, securing the payment of compensation according to the terms of the law. In our own case, the security required amounts to about 5 percent of the annual pay roll and about twice the amount due on approved awards under process of payment.

The experience under this provision has been satisfactory, not only in the saving over the rates of the state fund and casualty companies, but in the promptness of handling and payment of claims. Except in carrying his own risk and paying all claims directly, is the self-insurer any different from the other plans. All are subject to the rules and approval of the Industrial Accident Board.

That the filing of claims may be expedited the injured person is provided with a completed form by the attending physician, giving the necessary data for the making of his claim, which is filled out and forwarded to the board. After the waiting period (seven days) the claimant is permitted to draw his compensation as he desires. The waiting period only applies in full up to four weeks, after which he receives one day back for each week and at the end of seven weeks he is paid for the full time. Since the law and the procedure are specific, the majority of the cases can be paid and closed and the approval of the board assured. This feature of promptness appeals to both parties; the employe receives his money promptly, when he needs it most and the employer can keep his files clear of cases in process of payment.

In addition to the status of "self-insurer" the company has in force a "catastrophe" policy which covers all losses over ten thousand dollars in a single accident. The premium on this is nominal and its desirability is obvious.

In the decisions of the courts in cases involving the question of total permanent disability following a partial permanent disability it has been uniformly held that the total falls upon the employer though he was in no way responsible for the first injury. This condition made an employe or applicant who had lost a major member an "extra hazard" and while the company has never dispensed with the services of an employe because of this, it could not very well accept men thus handicapped. This created a condition which was an injustice to men who had lost an eye or a hand or a foot but were in all other respects capable of doing good work. A fruitless effort was made to find a company that would issue a policy that would cover this risk.

In 1926 this department took the matter to the Industrial Accident Board and through its then chairman, Mr. G. M. Suppiger, a plan was evolved which was adopted by the legislature and made part of the law, which, stated briefly, is as follows: A fund was created and maintained, known as the Industrial Special Indemnity Fund, created and maintained by charging the employer (insurance carrier) 1 percent in excess of every loss in the schedule of injuries and by deducting 1 percent from every claim paid an injured employe. This plan has been carefully worked out from the data obtainable covering this class of injury; i. e., permanent partial followed by a permanent total. Thus the employer is directly responsible for the instant injury and the difference between that and the total is cared for by this fund.

* In charge of Compensation Department.

BUNKER HILL SMELTER

(*From page 623*)

again in 15 seconds. It will do this three times in succession, when the timer has to be reset. Outside of the power room, there are two remote-control stations, one in the treater and one on the spray chamber. By the installation of this automatic equipment, only one man per shift is necessary for operating the entire treater.

The accumulated fume in the chamber is ignited and sintered similar to the baghouse fume. The recovery is 150 tons per month on a two-blast-furnace basis. Assay is as follows:

Ag.	Cu.	Pb.	Fe.	Insol.	CaO.	S.	Zn.	Sb.	As.
7.5 oz.	.05%	67.0%	0.8%	1.0%	0.2%	1.0%	1.0%	0.6%	0.6%

BAGHOUSE

The smoke from the blast furnaces, lead refinery, and silver refinery is treated in a baghouse. The volume of gas from the refineries is 40,000 c. f. m. at 325 degrees F., and from the blast furnaces 100,000 c. f. m. at 260 degrees F.

Two fans are installed for handling this gas. Only one is used, the other being a spare. The draft at the furnaces is .3 to .4 in. of water, and the pressure in the baghouse varies from .2 to .5 in. of water.

The baghouse is a brick building divided into seven sections. Each section is divided into four chambers from the thimble floor down for the collection of the dust. There are 400 woolen bags, 18 in. in diameter and 30 ft. long, in each section.

The temperature at the baghouse inlet is kept below 200 degrees F. by the admission of air at fan inlet. This is only necessary for a short time during the hot summer weather. The flue thermometer at the baghouse inlet is equipped with an attachment which blows a horn when the temperature reaches 200 degrees F., to notify the operator.

Only six sections are used for the blast furnace and refineries smoke. The other section is used for filtering the smoke from the by-product furnace.

The bags are shaken every four hours. They are suspended from a rod with the top end fitted over a sheet-iron thimble and the lower end over the floor thimble. The rods at the top of the bags are attached to a chain which leads to an eccentric on a motor-driven shaft at one end and a spring at the other end.

When the chambers have a sufficient accumulation of fume, they are opened, the fume is ignited and allowed to sinter. There is sufficient carbonaceous material in it so that it sinters readily. This product is either put in the D. & L. charge or smelted direct in the blast furnaces. The sintered fume assays as shown in the table at bottom of page.

Seven hundred fifty tons of fume are recovered per month on a two-blast-furnace basis.

The outlet gases from the baghouse and Cottrell treater are conducted to a double Sirocco-type fan, and then to the stack, which is 15 ft. in diameter and 200 ft. high. This fan is capable of handling 300,000 cu. ft. of air at 100 r. p. m. and 150 hp. The motor for this fan is variable speed, so the suction in the Cottrell and baghouse can be regulated as desired.

A McMichael automatic sampler is installed on the stack at an elevation of 75 ft. This sampler shows an average lead loss in the stack gases of 300 lbs. per day.

THE STAFF

The smelter staff is composed of the following: Frank M. Smith, director; A. F. Beasley, smelter superintendent; P. C. Fedderson, assistant smelter superintendent; J. B. Schuettenhelm, assistant smelter superintendent; J. W. Johnson, superintendent of lead refinery; Archie Donaldson, superintendent of silver refinery; A. L. Larson, mechanical superintendent; Sidney Butler, foreman, roasters and blast furnaces; D. R. Gettinger, chief chemist; G. C. Gage, office manager.

Ag.	Cu.	Pb.	Fe.	Insol.	CaO.	S.	Zn.	Sb.	As.
3.5 oz.	0.1%	63.0%	.3%	1.0%	0.3%	6.8%	10.0%	1.3%	0.3%

CENSUS OF LEAD AND ZINC MINING PRESENTS DATA NEVER BEFORE AVAILABLE

The Bureau of the Census of the Department of Commerce, in its recent survey collected some interesting figures regarding operations in the mining industry that have never before been available. On this page and the one following, this data is given for the lead and zinc mining industries for 1929, by states. Excepting a few major items, this presentation marks the first time this material has been published.

The lead-mining industry embraces those enterprises in which lead is the most important metal (based on net mine value) contained in the ore mined (or concentrates produced). Data for milling operations are included in the figures shown, but those for smelting and refining are excluded. Data for lead produced by those enterprises in which the principal values in the ore represent metals other than lead are included in the reports for the industries of the metals of greatest value.

Detailed General Statistics for the Lead Mining Industry, 1929

Prepared under the direction of F. E. Berquist, Statistician for Mines and Quarries

	United States	Missouri	Idaho	Utah	Colorado	Montana	Oklahoma	Kansas	Arizona	Other States[1]
Number of enterprises[2]	155	13	28	29	18	16	6	7	13	25
Number of mines	171	15	32	34	20	17	6	7	13	27
Persons engaged in industry (total)	15,004	4,173	3,366	4,244	787	418	412	297	343	964
Proprietors and firm members	53	6	7	.....	3	10	.....	2	9	16
Principal salaried officers of corporations[3]	72	11	16	21	3	7	4	2	.....	8
Other salaried officers & employes[3]	872	383	154	140	48	22	18	11	25	71
Wage earners (average for year)[4]	14,007	3,773	3,189	4,083	733	379	390	282	309	869
Principal expenses:										
Salaries and wages—										
Principal officers of corporations[3]	$370,344	$36,703	$90,372	$154,192	$4,500	$5,842	$21,280	$7,000	.....	$50,455
Other salaried officers and employes[3]	$2,175,806	$947,480	$381,280	$368,090	$120,809	$51,833	$54,124	$23,677	$47,212	$181,301
Wage earners	$22,917,435	$5,909,659	$5,787,889	$6,691,787	$1,449,608	$656,643	$528,097	$349,512	$398,348	$1,145,592
Contract work	$1,032,085	$47,157	$65,166	$807,558	$4,827	$23,249	$12,870	$18,346	$22,143	$30,769
Supplies	$10,377,787	$2,574,206	$2,531,180	$3,093,277	$568,503	$317,328	$280,596	$259,728	$219,764	$533,205
Fuel	$680,700	$306,579	$104,822	$86,846	$22,438	$15,345	$36,062	$27,659	$23,636	$57,313
Purchased electric energy	$3,733,230	$1,679,168	$701,540	$776,564	$178,652	$48,419	$73,076	$40,636	.....	$235,180
Expenditures for development included in principal expenses	$5,666,000	$824,000	$791,000	$2,693,000	$377,000	$205,000	$18,000	$29,000	$201,000	$528,000
Total value of products[5]	$67,561,778	$22,955,417	$17,400,861	$17,249,862	$2,946,136	$1,581,577	$1,508,124	$1,122,822	$770,543	$2,026,436
Machinery & other equipment purchased during year, total cost	$1,903,966	$54,000	$650,257	$591,019	$159,273	$39,572	$24,771	$1,92[illegible]	$114,612	$268,539
Prime movers & elec. motors driven by purchased energy, aggregate hp	194,380	80,432	55,836	30,178	6,851	3,250	4,281	3,559	1,917	8,076
Prime movers, total hp	38,234	21,911	5,987	1,642	931	585	1,380	2,010	1,917	1,871
Steam engines	43	7	1	9	6	4	2	.....	1	13
Horsepower	7,618	4,215	200	1,630	302	400	170	.....	22	679
Steam turbines	9	7	2	.....	.....	.....	.....	.....	.....	.....
Horsepower	19,336	17,336	2,000	.....	.....	.....	.....	.....	.....	.....
Internal-combustion engines	84	3	9	2	1	2	12	16	15	23
Horsepower	7,813	360	724	12	225	185	1,210	2,010	1,895	1,192
Water wheels & turbines	12	.....	10	.....	2	.....	.....	.....	.....	.....
Horsepower	3,467	.....	3,063	.....	404	.....	.....	.....	.....	.....
Electric motors driven by purchased energy	4,370	1,466	1,575	667	157	11[illegible]	67	59	.....	270
Horsepower	156,146	58,521	49,849	28,536	5,920	2,665	2,901	1,549	.....	6,205
Electric motors driven by energy generated by enterprises reporting	411	298	75	.....	.....	.....	.....	.....	37	1
Horsepower	16,422	14,545	1,200	.....	.....	.....	.....	.....	672	5
Electric generators	27	14	6	.....	.....	.....	.....	.....	5	2
Kilowatts	20,703	18,661	1,235	.....	.....	.....	.....	.....	775	32
Fuel and electric energy consumed										
Fuel—										
Anthracite (tons, 2,240 lbs)	4,766	.....	.....	27	.....	20	.....	.....	.....	4,719
Bituminous (tons, 2,000 lbs)	131,059	91,249	11,886	23,044	2,893	12	272	95	.....	1,608
Fuel oils (gallons)	970,506	15,740	175,726	89,701	.....	197,469	.....	.....	322,113	169,757
Gasoline and kerosene (gallons)	108,402	4,123	10,652	20,551	3,140	6,634	6,870	15,000	1,706	39,723
Gas (natural); m cubic feet	132,344	.....	.....	.....	.....	.....	64,472	67,872	.....	.....
Electric energy—										
Generated by enterprises reporting (K.W. hours)	50,718,102	40,825,381	6,362,561	.....	420,960	.....	.....	.....	3,109,200	.....
Purchased by enterprises reporting (K.W. hours)	447,702,056	168,645,516	102,690,377	126,507,243	16,185,921	6,551,468	4,215,163	2,594,116	.....	20,312,252

[1] Ark., 2 enterprises; Calif., 4; Nev., 9; N. Mex., 5; Tex., 1; Va., 1; Wash., 2; Wis., 1.

[2] "Number of enterprises" represents number of returns received. In some cases a return covers an individual mine and in others a group of mines. A company operating in several counties was required to make a return for operations in each county separately. In some instances a separate return for each mine operated by a company within a single county was received. The number of enterprises is therefore somewhat greater than the number of operating companies.

[3] Not including data for number and salaries of officers and employes of central administrative offices.

[4] The average number of wage earners is calculated by totaling the numbers reported for the several months of the year (in most cases the number on the pay roll on the 15th) and dividing the sum by 12.

[5] F. O. B. mine value of ore or concentrates.

Net Mine Value of Products of the Lead Mining Industry Showing the Values Contributed by the Metals Contained in the Ore or Concentrates[1]

	United States	Missouri	Idaho	Utah	Colorado	Montana	Oklahoma	Kansas	Arizona	Other States[2]
Total value of products	$67,561,778	$22,955,417	$17,400,861	$17,249,862	$2,946,136	$1,581,577	$1,508,124	$1,122,822	$770,543	$2,026,436
Value contributed by—										
Lead (in ore or concentrates)[3]	48,657,390	22,639,715	12,211,564	8,833,810	1,112,756	788,645	919,798	670,890	410,596	1,069,616
Zinc (in ore or concentrates)	7,560,963	283,737	2,216,230	2,059,021	773,176	367,570	588,326	451,010	95,189	726,704
Silver (in ore or concentrates)	6,949,065	30,448	2,186,088	3,707,048	404,101	346,730	.....	.....	114,922	159,728
Copper (in ore or concentrates)	1,336,122	.....	38,099	1,001,628	136,497	49,637	.....	.....	97,615	12,646
Gold (in ore or concentrates)	1,171,155	.....	174,367	715,608	177,463	28,995	.....	.....	52,221	22,501
Other products and service[4]	1,887,083	1,517	574,513	932,747	342,143	.....	.....	922	.....	35,241

[1] The "value of products" for census purposes represents the value of the product as it leaves the mine, whether as ore or concentrates. The product is sold (or transferred to affiliated plants) as ore or concentrates, and the returns are based upon the recoverable content of the metals contained. Although records of the separate values for each of the metals are not kept by some operators, these were able to give, in most instances, good estimates of the net value at the mine of the metals contained in the ore or concentrates. The figures shown in this table represent the net mine value of the product showing the contribution to the total value of the different metals contained in the ore or concentrates.

[2] Ark., 2 enterprises; Calif., 4; Nev., 9; N. Mex., 5; Tex., 1; Va., 1; Wash., 2; Wis., 1.

[3] The figures shown for the value of lead do not include the data for value of lead derived from gold, silver, copper, zinc or other mines.

[4] Iron, barite, limestone, custom milling, and misc. service.

DETAILED GENERAL STATISTICS FOR THE ZINC-MINING INDUSTRY

(*See introductory note on preceding page*)

The zinc-mining industry embraces those enterprises in which zinc is the most important metal (based on net mine value) contained in the ore mined (or concentrates produced). Data for milling operations are included in the figures shown, but those for smelting and refining are excluded. Data for zinc produced by those enterprises in which the principal values in the ore represent metals other than zinc are included in the reports for the industries of the metals of greatest value.

Detailed General Statistics for the Zinc Mining Industry, 1929

Prepared under the direction of F. E. Berquist, Statistician for Mines and Quarries

	United States	Oklahoma	Kansas	New Mexico	Wisconsin	Idaho	Colorado	Missouri	Montana & Nevada	Other States[1]
Number of enterprises[2]	148	57	30	8	9	6	9	11	8	10
Number of mines	204	87	45	9	9	7	10	14	8	15
Persons engaged in industry (total)	12,799	4,372	2,563	1,101	317	480	263	281	1,182	2,240
Proprietors and firm members	25	7	.....	.....	4	.....	8	2	3	1
Principal salaried officers of corporations[3]	74	36	25	1	5	.....	2	1	1	3
Other salaried officers & employes[3]	800	212	110	64	24	21	15	12	67	275
Wage earners (average for year)[4]	11,900	4,117	2,428	1,036	284	459	238	266	1,111	1,961
Principal expenses:										
Salaries and wages—										
Principal officers of corporations[3]	$379,383	$254,973	$95,310	$1,800	$10,700	.....	$4,200	$2,800	$500	$9,100
Other salaried officers and employes[3]	$2,127,881	$546,276	$316,059	$191,093	$43,874	$42,055	$40,275	$26,265	$212,582	$709,402
Wage earners	$16,274,339	$5,509,272	$3,140,236	$1,429,239	$363,961	$692,602	$365,137	$323,175	$1,932,044	$2,518,673
Contract work	$621,478	$229,218	$119,936	$96,919	$24,252	$4,493	.....	$8,356	$649	$137,655
Supplies	$7,965,885	$3,248,176	$1,685,967	$782,911	$202,521	$420,856	$140,440	$122,326	$586,047	$776,641
Fuel	$855,305	$317,021	$107,664	$64,043	$5,817	$3,906	$7,903	$18,882	$48,899	$281,170
Purchased electric energy	$2,369,198	$831,517	$667,274	$97,343	$151,108	$67,150	$88,672	$63,461	$181,913	$220,760
Expenditures for development included in principal expenses	$2,506,000	$344,000	$258,000	$714,000	$36,000	$210,000	$125,000	$34,000	$477,000	$308,000
Total value of products[5]	$44,866,026	$16,518,953	$9,912,331	$4,046,072	$1,326,162	$1,240,562	$906,538	$638,031	$3,379,142	$6,898,235
Machinery & other equipment purchased during year, total cost	$1,847,978	$552,467	$337,470	$163,998	$4,394	$14,542	$8,746	$81,225	$60,138	$594,998
Prime movers & elec. motors driven by purchased energy, aggregate hp	163,357	57,558	33,840	8,102	4,523	3,743	4,069	4,456	16,004	31,062
Prime movers, total hp	55,829	19,220	8,414	6,219	.....	750	55	1,760	810	18,601
Steam engines	33	2	6	.....	.....	.....	.....	19	7	8
Horsepower	6,019	190	600	.....	.....	.....	.....	801	625	3,803
Steam turbines	7	.....	.....	2	.....	.....	.....	.....	.....	5
Horsepower	18,252	.....	.....	4,000	.....	.....	.....	.....	.....	14,252
Internal-combustion engines	263	126	82	14	.....	1	1	11	4	25
Horsepower	30,758	19,030	7,814	2,219	.....	.....	15	959	185	536
Water wheels & turbines	5	.....	.....	.....	.....	3	1	.....	.....	1
Horsepower	800	.....	.....	.....	.....	750	40	.....	.....	10
Electric motors driven by purchased energy	2,577	979	648	58	160	61	27	45	288	308
Horsepower	107,528	38,338	25,426	1,883	4,523	2,993	4,014	2,696	15,194	12,461
Electric motors driven by energy generated by enterprises reporting	740	177	.....	231	.....	.....	.....	.....	7	322
Horsepower	17,206	4,466	.....	4,195	.....	.....	.....	.....	55	8,490
Electric generators	25	3	.....	13	.....	.....	.....	.....	4	5
Kilowatts	19,687	4,800	.....	4,120	.....	.....	.....	.....	132	10,635
Fuel and electric energy consumed										
Fuel—										
Anthracite (tons, 2,240 lbs)	59,783	.....	342	.....	.....	.....	.....	.....	.....	59,441
Bituminous (tons, 2,000 lbs)	46,859	6,640	1,553	12,123	1,011	370	1,113	2,595	11,261	9,893
Fuel oils (gallons)	2,021,425	1,352,019	48,907	375,203	.....	.....	2,450	12,000	15,000	215,846
Gasoline and kerosene (gallons)	261,701	110,922	37,915	2,975	8,430	.....	.....	3,500	.....	97,959
Gas (natural); m cubic feet	784,183	545,719	233,700	.....	.....	.....	.....	4,764	.....	.....
Electric energy—										
Generated by enterprises reporting (K.W. hours)	54,746,006	16,268,500	.....	14,459,423	.....	2,618,560	.....	.....	226,500	21,173,023
Purchased by enterprises reporting (K.W. hours)	196,948,992	68,785,878	47,304,970	5,004,700	7,128,926	10,150,258	6,886,000	3,604,303	24,296,852	23,787,105

[1] Ariz., 1 enterprise; N. J., 1; N. Y., 1; Tenn., 4; Utah, 1; Va., 1; Wash., 1.

[2] "Number of enterprises" represents number of returns received. In some cases a return covers an individual mine and in others a group of mines. A company operating in several counties was required to make a return for operations in each county separately. In some instances a separate return for each mine operated by a company within a single county was received. The number of enterprises is therefore somewhat greater than the number of operating companies.

[3] Not including data for number and salaries of officers and employes of central administrative offices.

[4] The average number of wage earners is calculated by totaling the numbers reported for the several months of the year (in most cases the number on the pay roll on the 15th) and dividing the sum by 12.

[5] F. O. B. mine value of ore or concentrates.

Net Mine Value of Products of the Zinc Mining Industry Showing the Values Contributed by the Metals Contained in the Ore or Concentrates[1]

	United States	Oklahoma	Kansas	New Mexico	Wisconsin	Idaho	Colorado	Missouri	Montana & Nevada	Other States[2]
Total value of products	$44,866,026	$16,518,953	$9,912,331	$4,046,072	$1,326,162	$1,240,562	$906,538	$638,031	$3,379,142	$6,898,235
Value contributed by—										
Zinc (in ore or concentrates)[3]	34,818,381	12,849,950	7,728,264	2,405,282	1,166,117	739,618	618,800	617,325	2,358,488	6,334,537
Lead (in ore or concentrates)	7,663,266	3,557,303	2,183,697	600,911	160,045	416,568	194,544	6,906	512,516	30,776
Silver (in ore or concentrates)	645,113	.....	.....	155,292	.....	68,001	71,159	.....	348,737	1,924
Copper (in ore or concentrates)	462,326	.....	.....	344,834	.....	.....	5,637	.....	110,397	1,458
Gold (in ore or concentrates)	260,668	.....	.....	203,753	.....	9	9,893	.....	46,167	846
Other products and service[4]	1,016,272	111,700	370	336,000	.....	16,366	6,505	13,800	2,837	528,694

[1] The "value of products" for census purposes represents the value of the product as it leaves the mine, whether as ore or concentrates. The product is sold (or transferred to affiliated plants) as ore or concentrates, and the returns are based upon the recoverable content of the metals contained. Although records of the separate values for each of the metals are not kept by some operators, these were able to give, in most instances, good estimates of the net value at the mine of the metals contained in the ore or concentrates. The figures shown in this table represent the net mine value of the product showing the contribution to the total value of the different metals contained in the ore or concentrates.

[2] Ariz., 1 enterprise; N. J., 1; N. Y., 1; Tenn., 4; Utah, 1; Va., 1; Wash., 1.

[3] The figures shown for the value of zinc do not include the data for value of zinc derived from gold, silver, lead, copper, or other mines.

[4] Crushed limestone, custom milling, power, and misc. service.

DISCIPLINE

In Relation to Accidents*

By Frank B. Dunbar†

ACCIDENT prevention and first aid were not considered to any extent by the mine management prior to the establishment of the United States Bureau of Mines. A few companies during 1910 became interested, however, no real effort was made until after the passage of compensation laws. Officials were more concerned in production. For a number of years the compensation was low and instead of accidents decreasing, they became more frequent, operating officials working under the idea that the insurance carrier would pay the bill. In some cases, the superintendent was not interested enough to investigate an accident.

In recent years, the compensation has increased, the insurance carrier has increased the rate and the cost has more than doubled, therefore the cost of accidents on a tonnage basis, has a prominent place on the cost sheet and the management has become vitally interested.

Mr. Rush N. Hosler, superintendent of coal mining section, Pennsylvania Compensation Rating and Inspection Bureau of Harrisburg, Pa., presented a paper at the Coal Mine Institute of America, on December 10, 1930, on economic losses in the Pennsylvania bituminous mining industry, resulting from injuries. I wish to quote a few figures from his paper. "In the five-year period 1925 to 1929, the cost of work injuries in Pennsylvania bituminous mining for compensation and medical treatment alone exceeded twenty-five million dollars or more than five million dollars per year, and that time lost on account of these injuries amounted to 21,384,423 lost days equaling 85,538 man-years. We can hardly grasp the enormity of these figures. The loss of time of more than 17,000 man-years per year, represents a wage loss of more than ten million dollars per year.

These appalling figures may mean more to us when expressed in cents per ton of coal mined. It was shown that the first item cost 3.6 cents per ton. This is trebled when the wage loss is added and becomes 10.8 cents per ton in counting the time lost in man-years. While Mr. Hosler's data represents Pennsylvania only, I believe it will compare in general with other bituminous fields in the United States.

Discipline and its relation to accidents is a subject that has been before the mining industry for a number of years. What does the management mean when they say "We have discipline at our mines, but we do not seem able to reduce our accidents." A number of prominent mining men are inclined to separate safety and costs. While safety should be the first consideration, we can not hope to operate a mine successfully without getting a reasonable return on the investment, therefore costs must be considered with safety and good mining practice.

Discipline and sufficient supervision will prevent accidents. Discipline means training or education. No mine can operate successfully unless the management has received proper training. No safety program can be carried out successfully unless all officials are properly trained and are in favor of carrying out all safety standards. It is folly to employ a safety engineer and mine inspector, purchase safety bulletins and literature, if you do it because the insurance company allows a rebate for a safety organization. The best safety engineer in the country can not get results without the support of the general management, as well as the cooperation of all officials.

I wish to stress particularly the necessity of training officials in proper mine management. These men must be of good moral character and know good mining practice. They must be familiar with all safety standards, be honest and sincere. Discipline means placing the mine in such condition that employes can work in safety; we may then go forward to the education and instruction of employes. In many cases, the mine management or general management having charge of a number of mines becomes discouraged, because they feel

* Presented to the 20th Annual Safety Congress, Chicago, October 13, 1931.

† General Manager, Mather Collieries Company, Mather, Pa.

their superior officers are more interested in production than they are in safety and accident prevention. These officers sit in conference with the general management; problems of major importance come up for discussion, and very often the question of accident prevention is not mentioned. The mine manager leaves the meeting with the feeling that production and costs are the all-important points. I attended such a meeting many years ago, and after the meeting one of the superintendents stated, "Well, the Governor wants only three things this year: more coal, cleaner coal, and cheaper coal." I have found after many years of experience, with discipline and sufficient supervision, production can be increased, costs reduced and accidents prevented.

The general management as well as the superintendent and his officials must consider the workmen as human beings, and not from the standpoint of a producer only. The face man must be considered as the important cog in the organization. These men are capable of thinking and the successful official will work with this thought in mind, and act as a trainer or teacher as well as a foreman. It has been said that working for accident prevention and safety is about the finest social training any person can have. Fairness and justice in your dealings with the workmen brings response of good-will and cooperation from all concerned.

In working for increased production, the management is inclined to criticise when the face man is slow in loading his wagon, when the locomotive is not hauling the number of trips prescribed by the efficiency engineer and when the turnover of pit cars is less than the management feels it should be. These are operating problems that the management is vitally interested in as costs are affected. However, discipline must be maintained, regardless of costs or production. It is a mistake to speed up the haulage beyond good safe practice; to rush the face man in loading his wagon, and not give him time to properly clean his coal or timber or his working place. He should not be hurried. Proper discipline in the inspection of all electrical and mechanical equipment is necessary.

We are all familiar with good operating practice, and should be using the safety devices that are practical. If our mine is in proper condition, haulage roads and man-ways clean, ventilation and drainage good, sufficient timber and supplies on hand, proper clearance on all haulage entries, potential hazards noted daily and taken care of before accidents occur, we will find the workmen contented, costs and production maintained. Our troubles are not with the face man. He will do his work in the majority of cases if he understands what should be done.

It is a pleasure to visit an assistant foreman's section where proper discipline is maintained. We find the tracks clean, rooms well posted and timbered, properly rock-dusted and sprinkled, man clearances everywhere, even on the curves at room necks, track in good condition, ribs properly trimmed, and the rib line in good shape. The "keep-safe" card in its proper place, tools in good condition and the face man working in safety. We find the fire boss, shot firers and coal inspector cooperating—all working for safety and accident prevention. Here are five men who are acting in an official capacity, visiting the working face many times a day, taking time to observe and note all potential hazards. If the workman is performing any unsafe practice, one of these men makes a note on the keep-safe card. If he continues to be careless and refuses to carry out instructions, he is discharged. The keep-safe card is a part of each employe's equipment, and is kept as a perpetual record. Should a man leave our employ and return to us at any time, his record is examined. If he was a safe workman, he will be employed, should there be an opening. If he was not, he will not be hired.

It is a mistake for a foreman to be hard-boiled with men. He should be an instructor rather than a boss. He should know his man, their families, their troubles, their likes and dislikes. If one of his men is sick or injured, he should visit with him. He should insist that man trips be provided. Workmen will not be good producers if they have three or four miles to walk every day in getting to and from their working face. Comfortable homes should be provided. An employe cannot think safety if he is worried about family affairs, if he is hungry or if he is being employed one or two days per week. I believe the use of the safety and potential hazard cards has been the outstanding factors in the maintenance of discipline at our mines.

If accidents are not reduced and compensation rates increase, there is something wrong with the management. Proper attention is not being given to accident prevention; investigations are not being made. Many times accidents occur that are not lost-time accidents and no investigations made. We must realize that any accident may result in a serious injury and a no-lost-time accident may become a fatal one next time. The potential hazard card will be a help along this line.

I was asked recently what percent of accidents are unavoidable, but I cannot answer that question. Some mines with dangerous conditions are able to operate months and in some cases, years, without a lost-time accident. Why cannot we go along for a number of years without accidents? Many managers state that they cannot afford to put on a safety program. However, if they will look up their compensation rate they will find that it is high. It would pay to get a disinterested, practical, mining man to make an examination of the mine and read his report. It may show that discipline, sufficient supervision and good management are needed.

Good housekeeping means safety. During the past number of years it has been a difficult matter for any company to operate at a profit, and many are operating at a severe loss. Under these circumstances, superintendents are inclined to reduce their labor to a minimum; the mine gets in bad condition, and accident costs increase.

Mr. H. C. Henrie, of the Phelps Dodge Corporation, had an excellent article in THE MINING CONGRESS JOURNAL recently on accident prevention work, and he states in referring to discipline, "After correct methods have been installed and the employes instructed in these methods, then safety rules and safe practices must be enforced, and employes of the company, irrespective of whether they be foremen, bosses or workmen, who cannot or will not show the necessary interest or cooperation, should be eliminated from the organization."

We as managers must insist on discipline if we hope to get anywhere with the accident prevention and safety program.

Referring to the use of the keep-safe card and the potential hazard card, I have used the keep-safe card for the past five years. This is a card provided for each (*Continued on page* 640)

Practical Operating Men's Department

METALS

Due to the cooperation of Mr. Guy N. Bjorge in the preparation of the articles on the operations of the Bunker Hill & Sullivan Mining and Concentrating Company, which appear in this issue, the Metals Section of the Practical Operating Men's Department is omitted.

AUTOMATIC BLOCKS for Inclines and Double Track Slopes*

By S. H. Asht

Slope Haulage in Washington

MANY of the coal mines in the State of Washington are opened by double-track slopes which do not have kick-backs at the top landings for back-switching the trips. The cars are run out of the slope over a knuckle, and the momentum of the trip carries them over a slight up-grade for the length of the trip over a lighter knuckle, whence they run by gravity to the yard after being unhitched from the main hoisting cable on the fly. (Any haulage operations done on the fly are hazardous and not worth the risk.) The empty-car trips for either side of the slope are blocked above the slope mouth where they are attached to the cable, and after sprags or blocks have been removed, the trip is run over the knuckle and down the slope by gravity.

At other mines the coal trips are gathered at the mouth of the mine, which is some distance above the tipple, and conveyed from the top of a gravity-plane, incline, or parting to the tipple. Haulage of coal is therefore carried on in two distinct stages which require the trips to be blocked between the two stages.

Accidents are most likely to occur, and frequently do occur, when cars are being transferred from empty track on slopes and when being transferred to or from the gravity-plane ropes at the top of the gravity plane.

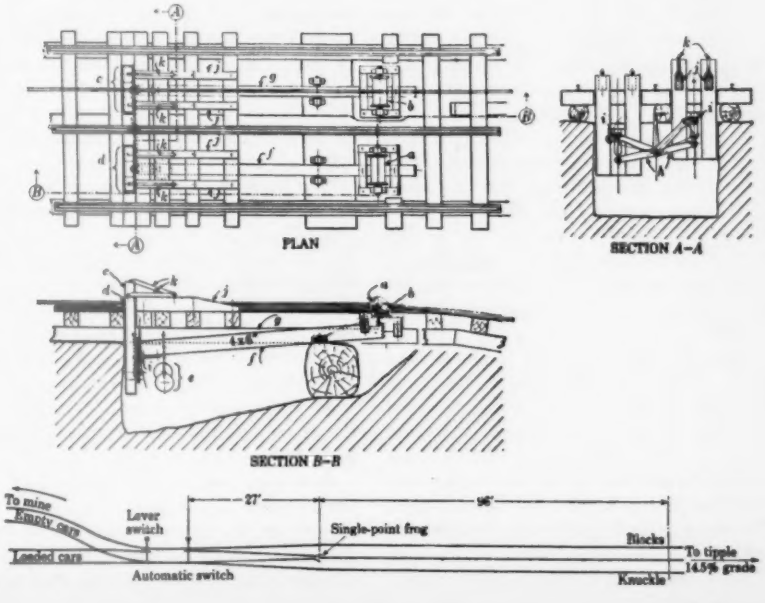
Protective Device at One Mine

The following description is of a device (see accompanying sketch) installed at the mine of the Roslyn Cascade Coal Co., Roslyn, Wash.:

The trips are gathered at the mine mouth and then lowered over a gravity plane to the tipple by means of a set of gravity-plane sheaves. The cars are handled in trips of 10. The weight of the average empty car is 850 lbs., and its weight loaded is 2,400 lbs; the size of rope is ⅞-in. The gravity plane, which is 3,400 ft. long, has an average grade of 14½ percent. The rails are of 30-lb. steel and the track gage is 30 in.

A pair of automatic blocks (*Figure 1*) holds the cars at the head of the plane. These are operated by the ropes on the gravity-plane, and are made of 4 by 6-in. timbers; they can be raised or lowered to any necessary height above or below the level of the tracks. At all times, except when the ropes are in tension and in contact with the pulley *a*, the block *b* is up and will block any cars above them. They are held in this position by means of the balance weights *e* and *l* attached to the levers as shown in the transverse section; the balance weight counterbalances the weight of the pulley and truck, and the weight of the rope when not in tension. When the trips are not in motion, one standing on the tipple, the other in the yard, the rope rests on either pulley.

As soon as a loaded trip has run out of the mine it is spragged in the yard and the mine rope is disconnected. The rope of the gravity-plane is then connected to the rear of the loaded trip. At a signal from the tipple that an empty trip is ready, the sprags are withdrawn and the loaded trip moves toward the tipple. To this point the blocks are both up, but as soon as there is tension in the rope on the empty-car track the rope pushes down the pulley *a* on which it rests. As this end of the lever *f* moves downward, the other end moves upward. This lever in turn is connected with the lever *h*, as shown, by means of a pointed strap passing through the hole *i*; this causes the end of the lever *h* to move upward while the other end, which is connected to the block *d*, moves downward, thus moving the block *d* downward, level with the tops of the rope guide *j*, and allows the loaded trip to pass. As soon as the loaded trip reaches the knuckle, the rope resting on the pulley *a*, the tension of the loaded trip rope causes *b* to move downward, which in the same manner as described causes the block *c* to move downward, allowing the empty trip to pass as it comes up the plane into the yard. As soon as the empty trip passes *a*, the block *d* goes up. As soon as the trips have been landed, the tension in the loaded trip rope on the pulley *a* is released and the block *c* goes up, thus blocking the empty trip above the knuckle. When both ropes are below the knuckle, both blocks are down. If for any reason when the trips are in motion below the knuckle the block on the empty-car track should fail to go down, instead of allowing the empty cars to run into the block and be wrecked, the front car of the trip would ride on the 1 by 1-in. irons *k*, which are hinged as shown, and push the blocks down to their proper position.



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† Mining Engineer, U. S. Bureau of Mines Safety Station, Berkeley, Calif.

Modern Mining *with* SCRAPERS *in* HIGH COAL

By G. B. Southward

Scraper loading has been quite widely adopted in metal mining but its progress in coal has gone more slowly. The beginnings of the present scraper development in coal were made about 15 years ago in the anthracite field, but in recent years the use in bituminous mining has surpassed anthracite. In 1930 the total production with scraper mining in the United States was approximately 3,000,000 tons.

Scrapers are operated in entry development, room advancement, pillar recovery, and on long face mining. In entries and narrow rooms some hand shoveling is employed, but in wide rooms and on long faces the scraper travels parallel to the face and loads automatically. The scoop can be set so that it will pull in against the face and have a very positive digging action. In long face work scrapers have a particular advantage in that there is no expensive equipment along the face to be endangered by roof falls.

Scrapers are used successfully in high and low coal—ranging from less than three feet to greater than six feet—but their application is better adapted to seams that have a hard floor as the scoop will dig up bottom in soft strata. There are very many mines which have conditions suitable for scrapers and present operations show that the performance of this equipment compares very favorably with other types of mechanized loading.

TWO reports are submitted with this article showing scraper mining in thick seams. These mines are located in different states and at first glance their operations appear to be quite different from each other. However, there are several points of similarity. The seam heights are approximately the same and in both cases the scraper loads from a long slab cut, although one is classed as a long face and the other as pillar recovery. In each mine the roof is supported on timbers and the operation is continued without interruption by the roof action until a sufficient area is excavated to get a roof fall.

Mine No. 44 operates a modified long face. Blocks of coal 300 ft. long and about 90 ft. wide are developed by driving narrow entries. This development work is done with mechanized loading and the blocks are mined with scrapers—slabbing a cut along the 300-ft. side. The scraper loads onto a conveyor at the end of the face—this conveys to a trip of mine cars on the entry. The top over the mined area is supported on timbers without caving until sufficient weight has developed so that a fall is about to occur. When this point is reached the face is discontinued and the operation moved to the next entry ahead. The coal remaining in the pillar is only a small portion of the total area mined and the recovery percentage is high.

The mine shown in Report No. 9 develops the rooms with mechanical loaders. These are driven 22 ft. wide and 300 ft. long, leaving a 50-ft. pillar between rooms. This pillar is recovered by scraper loading on slab cuts—dragging the coal to a trip of mine cars along the entry. The scraper work leaves a 50-ft. stump along the entry which is later recovered by hand. The roof in the room is supported on timbers until the pillar work is finished.

A comparison of the man-hours per ton in these two mines as given in the reports on the opposite page shows that the greater daily tonnage is reflected by a lower labor cost in the long face operation of No. 44. A great part of this can be accounted for by the difference in the sizes of the scrapers used—No. 9 having a capacity of 1.5 tons while No. 44 uses a larger type of 3.5 tons. Since the average length of scraper travel is 150 ft. in each mine, theoretically the productions should be in direct ratio to the sizes of the scoops and the small unit would have a daily tonnage of less than one-half that of the larger unit. In actual practice the difference is not so great as the smaller scoop can be operated more rapidly. This is shown by the fact that in these reports the production of the small scraper is two-thirds that of the larger type.

It is rather difficult to figure the exact amount of advantage which the larger unit offers. If we compare the labor used for similar operations on the faces (eliminating the items of slate picking and timbering), Mine No. 44 has a cost of .209 man-hours per ton as against a cost of .400 for Mine No. 9. This shows a difference of .191 man-hours in favor of the large scoop operation in No. 44. The drilling cost in mine No. 44 is .059 man-hours lower than in No. 9. If we subtract this from the total of .191 man-hours the remainder, amounting to .132 man-hours per ton, represents approximately the difference in the labor cost for the face work between these two reports which is due to the size of the scoops used.

The above figures are merely for the purpose of explaining the figures used in the reports and it must be emphasized that the comparison between the two types of equipment is not complete. For instance, the 3.5-ton scoop could not discharge directly into a 2¼-ton mine car and in Mine 44 there is a conveyor for distributing the scraper load which is not needed in Mine No. 9. The figures in the report do not include the cost of operating, maintaining and setting the conveyor and this cost would reduce the difference between the man-hours per ton shown for the two mines. Furthermore, the increased investment for the conveyor and for the larger scraper unit and the amount of power used must also be taken into consideration.

MECHANIZATION SURVEY OF THE AMERICAN MINING CONGRESS

THE AMERICAN MINING CONGRESS—MECHANIZATION DIVISION

Report No. 44—Scrapers On Long Faces

GENERAL DATA		DESCRIPTION OF OPERATION
Height of seam	7 ft. 6 in.	Scraper loading on 300 foot face--mining blocks 90 ft. wide—drags coal average distance of 150 ft. to conveyor at end of face which loads mine car trip. Roof supported on timbers while face advances from 75 to 90 feet.
Partings	3 in.	
Working place	300 ft. longface	
Depth of cut	8 ft.	
No. of men in crew	14	
Tons coal per shift	270 tons	

EQUIPMENT AND DISTRIBUTION OF LABOR

OPERATIONS	EQUIPMENT	No. Men	Hrs. Empl.	Man-Hrs. Empl.	Man Hrs. Per Ton
Cutting	1 Shortwall	2	8	16	.059
Drilling	1 Electric Hand Drill	2	4	8	.030
Shooting	Permissible With Battery	–	–	—	——
Scraper hoist operator	125 HP. Hoist	1	8	8	.030
Face scraper men	3.5 Ton Scoop	1	8	8	.030
Car trimmer	2.25 Ton Cars	1	8	8	.030
Gathering	Trolley Locomotive	1	8	8	.030
Picking slate	Hand	2	8	16	.059
Timbering	Posts and Cross Bars	4	8	32	.118
			Total man-hours per ton produced		.386

THE AMERICAN MINING CONGRESS—MECHANIZATION DIVISION

Report No. 9—Scrapers On Room Pillar Recovery

GENERAL DATA		DESCRIPTION OF OPERATION
Height of seam	6 ft. to 8 ft.	Scraper on room pillar recovery—pillars 50 ft. wide and 22 ft. rooms 300 ft. long. Scraper drags coal an average distance of 150 ft. and loads into mine car trip on entry. Roof supported on posts until pillar is rocovered.
Partings	0	
Working place	Room Pillars	
Depth of cut	7½ ft.	
No. of men in crew	10	
Tons coal per shift	180	

EQUIPMENT AND DISTRIBUTION OF LABOR

OPERATIONS	EQUIPMENT	No. Men	Hrs. Empl.	Man-Hrs. Empl.	Man Hrs. Per Ton
Cutting	1 Shortwall	2	8	16	.089
Drilling	1 Electric Post	2	8	16	.089
Shooting	Electric-surface	–	–	—	——
Scraper hoist operator	25 HP. Hoist	1	8	8	.045
Face scraper men	1 5 Ton Scoop	2	8	16	.089
Car trimmer	3 Ton Cars	1	8	8	.044
Gathering	Battery Locomotive	1	8	8	.044
Picking slate	——	–	–	—	——
Timbering	Wood Posts	1	8	8	.044
			Total man-hours per ton produced		.444

DISCIPLINE AND ACCIDENTS

(*From page* 636)

workmen, regardless of occupation. For officials and daymen, the card is placed in the most convenient location. The face man keeps the card near the working face, and it is considered part of his equipment. This card provides space for date, description of violation and the signature of the official.

The official in charge makes a copy of the violations and turns them in to the safety engineer monthly, for a perpetual record is kept. The information is also transferred to a large bulletin showing the record of each employe for the past six months.

The potential hazard card was placed in use the first of this year and was originally prepared by Mr. George McCay, mine inspector for the state of Pennsylvania. This card is used by officials only. The fire boss takes this card on his first round and makes a mark under the proper location of any hazard observed. After his examination has been completed, the card is turned over to the assistant foreman, who copies the hazards observed by the fire boss and the card is given back to the fire boss. Upon the fire boss's second round, any additional hazard observed is noted on the card. When the assistant foreman makes his rounds, if the hazards observed by the fire boss have been removed, circle will be placed around the dash which was made on the first visit. If orders have been given to remove the hazard, a cross is made in the proper column, and if the hazard has been removed, a circle will be made around the cross.

When the assistant foreman and fire boss meet on their rounds, they exchange information as to potential hazards noted on their cards. This system was carried out for some time and later on the coal inspector was furnished with a potential hazard card. Later on, shot firers will be given a card. Finally, five men visiting the section were traveling through the mine, making notes on the card of any potential hazards.

These cards are turned in to the general mine foreman at the end of a shift and if all hazards noted have not been removed, they must be taken care of or proper report made as to why the work has not been done.

In looking over many of the cards that have been turned in, a large number of marks are under the column headed "Needs Timbered," and quite a large number under "Loose Roof."

Before installing this system, it was customary for one official to inform the other sometimes in an off-hand manner as to roof conditions or other dangers. However, in this system, correct notation is made and a copy taken and a method provided for a checking, making sure the hazard has been removed.

The potential hazard card and the keep-safe card is a help in maintaining discipline.

Many times a question is asked, "How do you maintain discipline?" And the answer is, "When an employe is found performing an unsafe practice, send him home for the day." A foreman will not get anywhere by scolding or using profane language. He should instruct his men in safe methods and see that proper methods are carried out, and if the workman will not obey him, send him out and get a timberman or other workman to make the working place safe.

MINING METHODS AT BUNKER HILL

(*From page* 608)

These costs are further divided under the headings of Exploration, Stoping, Tramming, Hoisting, Pumping, as shown in the following table:

	Exploration	Stoping	Tramming	Hoisting	Pumping	Total Cost per Ton
Labor	.063	1.914	.037	.039	.025	2.078
Supplies	.048	.752	.017	.024	.016	.856
Miscellaneous	.031	.692	.038	.032	.066	.861
Total normal cost	.142	3.358	.092	.095	.107	3.795
Extraordinary	.001	.038	.001	.001	.001	.039
Diamond drilling	.007	....	....	....	....	.007
Total	.1511	3.396	.092	.095	.107	3.841

EXPLORATION—6,057 FEET

	Cost, ft.
Labor	$4.798
Supplies	3.586
Miscellaneous	2.355
Total normal cost	$10.739
Extraordinary	.009
Diamond drilling	.621
Total cost per foot	$11.369

ELECTROLYTIC ZINC PLANT

(*From page* 626)

casts, statuary, and other objects. Alloys containing cadmium are used in non-rusting hairsprings for various watches and clocks. For the manufacture of electric light filaments one of the earlier successful processes employed cadmium. An amalgam consisting of 42 percent of cadmium, 53 percent of mercury, and 5 percent of bismuth can be impregnated with tungsten metal powder and then extruded through dies to produce a raw filament which is later heated to a high temperature, to drive off the volatile metals. Five percent of cadmium is sometimes added to aluminum powder to improve the color and luster to make it more resistant to atmospheric influences.

Cadmium has been recommended for use in electric storage batteries. A battery having cadmium plates can be discharged completely and allowed to remain discharged indefinitely, whereas such abuse causes serious damage to ordinary lead batteries. As they cost fully twice as much as lead batteries, cadmium batteries have not been widely used, although there are several makes of miners' safety lamps employing an alkaline electrolyte, one nickel electrode, and instead of the usual iron electrode of the Edison battery, a mixture of iron and cadmium in a thin perforated metal case. Monochromatic red light for scientific investigation in physical laboratories is produced by means of cadmium. In the quartz-cadmium vapor lamp developed by the United States Bureau of Standards the cadmium is alloyed with a very small fraction of 1 percent of gallium, giving a long lived lamp that does not become clouded by adhesion of cadmium vapor to the walls.

During the World War cadmium was declared contraband by most of the belligerents. This may have been due in part to its use as a substitute for tin, but (in addition to the ordinary industrial uses) cadmium was employed in smoke bombs and a cadmium band was placed on hard-jacketed cartridge bullets to take the rifling without undue wear on the barrel.

DRILLING FOR GOLD DEPOSITS USING OIL WELL CABLE TOOLS

Oil field equipment and methods are being used in a unique series of tests to locate a gold vein in an oil structure in Johnson County, Wyoming, by the Kaycee Mining Company, of Lovell, Wyo.

In 1921 the Cleveland Oil Company drilled a test on this same structure. This well got a showing of gold at 720 ft., it is said, and the bailer brought up cuttings from the hole which were heavy with gold.

The vein of gold proved to be 18 ft. thick. The dirt from the hole assayed $1,400 per ton. However, the Government would not allow mining for gold on an oil lease. So the hole went down for oil, and was abandoned as a dry test around 1,800 ft. Three shallow tests drilled nearby proved dry with showings of gold.

Two years ago the Kaycee Mining Company secured the oil leases. Through the efforts of J. H. Johnson, vice president, a special bill was passed by Congress allowing the permittee mineral rights if discovered on an oil lease.

At present the company is applying the oil well drilling method to test the direction, thickness and quality of the gold stratum. Cable tools are being used, and core drills are being run at intervals, according to structural indications.

TRI-STATE EXCELLENT CONVENTION HOST

THE joint convention of the Western Division of The American Mining Congress and the American Institute of Mining and Metallurgical Engineers, in conjunction with the Tri-State Lead and Zinc Ore Producers Assn., held at Joplin, Mo., September 27, 28, 29, and 30, turned the capital of the Tri-State Zinc and Lead Mining District into a mecca for some 325 delegates from Europe, South America, Mexico, Canada, and the United States.

The opening session was featured by a paper presented by C. K. Leith, chairman, department of geology, University of Wisconsin, entitled "Problems of Mineral Surplus." Dr. Leith said he believed a wider conservation law, instead of an attack on the anti-trust laws probably would be of more value to the mining industry in enabling it to find its way out of the dilemma presented by the surplus stocks of minerals, and the present surplus of productive capacities. Although the industry is faced, he went on to say, with what appears to be at present an enormous surplus of minerals; looking at the situation in its relations to the future, the country did not have sufficient reserves of minerals for public or national welfare. The problem of keeping the ores in the ground until they were needed was the problem the industry would have to solve, and it might be that closer cooperation between the Government and industry would help to solve the question.

Mr. Tally, president of the Institute and vice president and general manager of the United Verde Copper Co., in discussion of Dr. Leith's paper, urged that the mining industry act at once in trying to solve its overproductive capacities before some one outside the industry forced a solution that might not be to the industry's liking.

Mr. Tally urged Government encouragement of stabilization of prices, fair to the consumer himself, in order to conserve the mineral resources of the country. He further stated that the destructive prices of today made it a crime to further deplete the mineral resources of the United States.

R. M. Atwater, Jr., of New York, president of the Interstate Lead and Zinc Co., suggested that possibly, if the "blue sky" commissions of the various states would refuse to allow the sale of mine securities until such promotions were indorsed by the Institute that it would help retard the development of new properties. The indorsement of new promotions would not be made, according to his idea, unless additional production of the mineral in question was needed.

Judge A. Scott Thompson, attorney, Miami, Okla., said that, in spite of the anti-trust laws, we are compelled by the state militia of Oklahoma and Texas, to reduce oil and cotton production. "How long will it be before the governor of any state will call out the militia to tell us not only how much cotton and corn, wheat and oil, we may produce; but how many hours we may work and for what wages?" he asked.

The convention was officially opened at 2 p. m., on Sunday afternoon, September 27, by a conference of the engineering committee of the A. I. M. E. Mr. Charles H. Fulton, director, Missouri School of Mines, at Rolla, Mo., presided over the meeting.

The Monday morning session was opened by Judge A. Scott Thompson with an address of welcome. Robert E. Tally presided. J. F. Callbreath, secretary of The American Mining Congress, in his response address reviewed the registration list of the 1907 meeting of The American Mining Congress at Joplin, calling the roll of distinguished men who have since passed away, and the roll of those men who are still living since the 1907 convention, and also the roll for 1931. He then discussed the necessity for anti-trust legislation, pleading for the removal of "the twilight zone, which rogues freely enter while honest men hesitate."

The first paper presented was by J. C. Heilman, mining engineer, Baxter Springs, entitled, "Mining and Economic Conditions in the Tri-State District."

The topic before the afternoon session was "Geology and Ore Deposits of the Mississippi Valley Type." Three papers were presented at this session. Messrs. M. W. Hayward and W. H. Triplett, geologists, Cia. Minera de Penoles, Monterrey, Mexico, discussed the "Occurrence of Lead-Zinc Ores in the Dolomitic Limestones of Northern Mexico." This was followed by a paper on the "Ore Deposits of the Tri-State District," presented by George M. Fowler and Joseph P. Lyden, geologists, Joplin, Mo. H. A. Buehler then presented his paper, "Geology and Ore Deposits in the Ozark Region."

Monday evening was featured by an excursion to the Mining Museum in Schifferdecker Park, Joplin. A collection of lead and zinc specimens were exhibited, together with an exposition of progress, which showed the mechanical advancement of the lead and zinc industry. Later in the evening an informal smoker was held on the roof of the Conner Hotel, headquarters for the convention. The most novel feature of the smoker was an old fashioned, 50-odd-year-old bar, which included a bartender dressed in the typical clothes of a bartender of 50 years ago, including his ascot tie and stickpin.

The Western Division of The American Mining Congress held its meetings on Tuesday, September 29. The morning session opened at 9.30 a. m. with Mr. C. F. Dike, governor, Western Division, American Mining Congress, acting as chairman. Congressman Joe J. Manlove, ranking member of the House of Representatives' "Committee on Mines and Mining," presented the first paper of the morning on "Probable Mining Legislation."

Representative Manlove opened his paper with an invitation to the members of the Western Division to make any suggestions they wished to the "Committee on Mines and Mining" which they thought should be worked into the law. Mr. Manlove said that he believed the anti-trust laws should be so amended as to permit agreement among operators which would curtail output. He advocated, however, that such an agreement should be under the supervision of a governmental agency. After stating that the difficulty with the anti-trust law lay in "unreasonable restraint of trade," he said, "to my mind, a judicial body clothed with authority to advise operators and thereby absolve them from the possibility of persecution, should be established." Mr. Manlove went on to state that "relief can not come through any subterfuge. Therefore, it behooves the mining industry to present to Congress a program of education, clearly outlining the necessity for such amendments to the anti-trust laws as will make well regulated operation and distribution possible." He predicted that a day would come when governmental control of mines would be sought. He warned, in closing his speech, against the doctrine of discontent as preached by the Russian communists and appealed to the mining industry to stand, as never before, for the enforcement of the law and the elimination of evil sentiments.

Mr. J. F. Callbreath presented the second paper of the morning, "Problems Facing Mineral Producers." He listed the major problems facing the mineral producers as taxation; the remedy for silver, stabilization of production; maintenance of a protective tariff; freight rates; and proposals to put Government into business.

Mr. R. E. Tally, president, A. I. M. E. and past president of A. M. C., presented a paper, "Regulating Mineral Production to Meet Demand."

At 12 o'clock a luncheon was held for the board of governors of the A. M. C. in the Gold Room of the Conner Hotel. Other members of the convention were feted by a luncheon in the roof garden.

Victor Rakowsky, mining engineer, Joplin, Mo., presided over the afternoon session. In furthering the general topic of "Western Mineral Problems," papers were presented by Mr. W. Mont Ferry, Mr. A. W. Dickinson, chief tax division, A. M. C., and Dean Frank H. Probert.

The discussion of the now all important question of silver was taken up at the fifth meeting held on Tuesday afternoon, when W. Mont Ferry, vice president and managing director of Silver King Coalition Mines Co., and president of the Silver Producers Assn., presented his paper, "The World Silver Situation." Mr. Ferry reminded the delegates that the credit structure of the world is founded on too narrow a basis, showing this through a relationship between production of gold and the increase in business; gold increased 1½ percent per annum in production, while business increased from 3 to 5 percent.

Mr. Ferry advocated the calling of an international conference on silver, which he stated he has urged President Hoover to call, at which the leaders of the American industry should take a leading role and formulate some constructive plans for the rehabilitation of silver and the credit structure of the world. Such a plan could be formulated, he predicted, and the rest of the world would be obliged to follow the plan if vigorously supported by the United States. "The production of gold will begin to decline in 1934," Mr. Ferry said, "and by 1945 will probably be 25 percent less than it is now." For that reason he believed that confidence in silver should be restored.

Frank H. Probert, dean of the department of mines at the University of California, presented a paper on "Stabilization of our Natural Resources." This paper will appear in full in the December issue of THE MINING CONGRESS JOURNAL.

Mr. Dickinson, in speaking of "National Revenue and Mining," said, "that from past lessons it is now recognized that taxes should be paid in accordance to one's ability to pay." Mr. Dickinson stressed the thought that our income tax laws were created to meet an emergency, and that they have not, as yet, reached their final form." He also said, "the attitude of the governmental bodies, both legislative and administrative, in the matter of Federal mining taxation is all that we of the industry can ask, but, we must be very alert and ready to present the beliefs and opinions necessary in the protection of our best interests as there is much that is insufficient and unknown." In conclusion he stated that, "whether Congress shall enact any changes in our income tax law can not be predicted at this time; but it is certain that the industry should be at the elbows of the congressional committee, ready to furnish them with the basic facts concerning which legislation is sought in order that the final conclusion may help and not hinder the industry."

On the evening of the 29th of September, an informal banquet and dance was held on the roof of the Connor Hotel. Charles A. Neal, president, Tri-State Zinc and Lead Ore Producers Association, served as toastmaster. H. Foster Bain and Senator Cliff Titus, Mo., addressed the banquet, speaking on "Recent Observations in Europe," and "Chats," respectively.

The third day of the convention, Wednesday, September 30, was spent on an all day field trip through the Tri-State District which Representative Manlove so aptly termed, "The Little Empire." The party left the Connor Hotel by automobile at 8.30 a. m., arriving at their first stopping place at Gelena, Kans., to see the Eagle Picher Lead Smelter plant. The 100,000 horsepower steam plant of the Empire District Electric Co., at Riverton, Kans., was the next stopping place. The next half hour offered two beautiful pictures to the party; one in the form of an old cattle trail to the Southwest at Baxter Springs, Kans., and the other a view of the Oklahoma-Kansas Mining Field at Picher, Okla. At 10 o'clock the party stopped for an underground trip through the Blue Goose and Angora mines of the Commerce Mining and Royalty Co., and the Shorthorn mine of the Bilhartz Mining Co. The caravan stopped for luncheon and a view of the "Commerce" mining field at Miami, Okla. Immediately after lunch the "Boys Mounted Troop of America" gave a rodeo exhibition at the Miami Fair Grounds, which turned out to be a delightful break from the practicality of the trip. The rest of the afternoon was spent in looking over the 10,500 horsepower Diesel plant of the Commerce Mining and Royalty Co., at Cardin, Okla., and inspecting the Bird Dog Mill of the same company. The party arrived home at Joplin again about 6 p. m.

The fair grounds at Miami, where the ladies' trip and that of the men met, furnished a colorful background for the luncheon. Old fashioned darkies served out barbecues, while the rodeo was staging its acts for the audience. A most humorous episode was furnished by an 8-year-old youngster, when he attempted and succeeded in roping and bull-dogging a calf. Many of the party took advantage of the airway at Miami to get a more perspective view of the mining fields.

The ladies, as well as the men, were afforded a delightful time at the convention. On Monday they were entertained at luncheon at the Oak Golf Club. Following this they were given a delightful automobile trip through the Ozarks, returning to fill a dinner and entertainment engagement at "Cedarhurst." Tuesday was featured by a bridge party at the Women's Club in the afternoon, and the banquet on the Roof Garden of the Connor Hotel at night. On Wednesday the women were taken on a special field trip through the Picher Mining Field via Miami, Baxter Springs, and Kansas Blue Mound. They were given a reception and luncheon at the Rockdale Country Club, Miami, and, following this, met the men at the Miami Fair Grounds for the rodeo and the return trip to Joplin.

At the Tuesday meeting three new members were added to the board of governors. These were: Ernest N. Patty, of Seattle; R. M. Henderson, of Leadville, Colo., and Chas. A. Neal, of Miami, Okla. The entire board of governors for the ensuing year stands as follows:

ALASKA—Ernest N. Patty, Seattle; Chas. D. Garfield, Seattle.
ARIZONA—T. H. O'Brien, Miami; W. B. Gohring, Phoenix.
CALIFORNIA—Philip Wiseman, Los Angeles; G. Chester Brown, San Francisco.
COLORADO—R. M. Henderson, Denver; C. Lorimer Colburn, Denver.
IDAHO—A. Ramstedt, Wallace; J. F. McCarthy, Wallace.
MONTANA—W. B. Daly, Butte; Chancey Berrien, Butte.
NEVADA—J. C. Kinnear, McGill; H. M. Rives, Reno.
NEW MEXICO—J. M. Sully, Santa Rita; J. F. Woodbury, Silver City.
OREGON—Robert M. Betts, Black Butte; A. W. Strowger, Portland.
OKLAHOMA—Chas. A. Neal, Miami; M. D. Harbaugh, Miami.
SOUTH DAKOTA—B. C. Yates, Lead; R. G. Wayland, Lead.
WEST TEXAS—Brent N. Rickard, El Paso; Howard H. Fields, El Paso.
UTAH—Oscar Friendly, Salt Lake City; A. G. Mackenzie, Salt Lake City.
WASHINGTON—Frank M. Smith, Seattle; Milnor Roberts, Seattle.

Recent reports of the Bureau of Mines of particular interest to our readers are listed below. Upon request, copies will be furnished by THE MINING CONGRESS JOURNAL.

Overheating of Rubber-Sheathed Trailing Cables (R. I. 3104).
State Mine Inspectors: Their Appointment, Qualifications and Remuneration (I. C. 6484).
Organization Plan of the Holmes Safety Association (I. C. 6481).
Chalk, Whiting and Whiting Substitutes (I. C. 6482).
Significant Features of Wire-Saw Operation in Europe (I. C. 6483).
Mining Laws of the Netherlands (I. C. 6477).
Mining Laws of Cuba (I. C. 6458).
Flotation of Low-Grade Phosphate Ores (R. I. 3105).
Leaching Oxidized Copper Ores: Effect of Strength of Acid in Leaching Solvent (R. I. 3106).
Flotation Reagents, 1929 (R. I. 3112).
Methods and Costs of Mining Quicksilver Ore at New Idria Mine, San Benito County, Calif. (I. C. 6462).
Methods and Costs of Mining Copper Ore at Verde Central Mines, Jerome, Ariz. (I. C. 6464).
Mining Methods and Costs at Porcupine United Gold Mines' Rochester Mine, Timmins, Ontario (I. C. 6470).
Tunnel Driving Methods Used at the Oquela Unit, Compania Minera de Pencles, Durango, Mexico (I. C. 6480).
Mining Methods of Kirkland Lake Gold Mining Company, Ontaria (I. C. 6490).
Underground Chute Gates in Metal Mines (I. C. 6495).
Milling Methods and Costs at Concentrator of Old Dominion Company, Globe, Ariz. (I. C. 6467).
Milling Methods and Costs at Argonaut Mill, Jackson, Calif. (I. C. 6476).
Milling Methods and Costs at Arthur and Magna Concentrators of Utah Copper Company (I. C. 6479).
Milling Methods and Costs at Verde Central Concentrator, Jerome, Ariz. (I. C. 6489).
Milling Methods at Midvale Concentrator of U. S. Smelting, Refining & Mining Company (I. C. 6492).
Essential Factors Influencing Subsidence and Ground Movement (I. C. 6501).
Safety Standards and Suggestions at Iron Mines in Lake Superior Region (I. C. 6510).
Geophysical Abstracts (I. C. 6528).
Study of Falls of Roof and Coal in Mines in Harrison County, W. Va. (R. I. 3110).
Re-Treatment of Sayreton Jig Middlings on Coal Washing Tables (R. I. 3101).
Effect of Certain Operating Variables on Efficiency of the Coal Washing Table (R. I. 3111).

CHAMBER OF COMMERCE URGES TRIBUNAL TO REGULATE NATURAL RESOURCE PRODUCTION

AMENDMENT of the anti-trust laws to provide for the appointment of a small tribunal which would be authorized to take measures for the stabilization of production in the natural resource industries, is recommended in a report of the Natural Resources Committee of the U. S. Chamber of Commerce. The Chamber's board of directors has directed that the recommendations of the committee, which is headed by Matthew S. Sloan, be sent to the entire membership for referendum vote.

The report is entitled "The Present Problem of the Oil, Coal, and Lumber Industries." The tribunal suggested, consisting of representatives of the Federal Government and enjoying the confidence both of the industries and the general public, would be authorized to determine whether a condition of overproduction which was not in the public interest existed in either the oil, coal, or lumber industries. Upon such a finding, the tribunal would be authorized to permit the units of the particular industry to enter into agreements to control the production of its commodity, provided the purpose was to bring production and consumption into balance, and was not primarily for the purpose of eliminating competition, establishing monopoly, or unduly increasing prices.

"Such an arrangement," says the committee, "would not result in the establishment of a large permanent Federal commission, and it should not result in the loss of initiative with the industries, or lead to the development of practices which would be inimical to public interest. Nor would it preclude the development of the trade practice conference, or of trade association activities. Under this provision the industries would, of course, not be prevented from adopting any of the various measures suggested for their betterment that do not require legislative aid."

Copies of this report may be obtained from THE MINING CONGRESS JOURNAL.

TARIFF COMMISSION HEARS PLEA FOR DUTY ON COPPER

DECLARING that the American copper producing industry had lost its former domination in the world copper trade and its foreign markets and that its domestic trade was threatened by increasing copper production in foreign countries, representatives of approximately 40 percent of the domestic copper producing interests at a hearing before the Tariff Commission on October 28 urged that body to include in its prospective report to Congress a complete outline of existing and prospective conditions in the domestic and world copper industry in order that Congress might be guided in placing an import duty on copper to preserve the domestic industry. This the commission promised to do, on presentation of arguments by Senator Ashurst and Representative Douglas, both of Arizona, that it was the intent of Congress in directing the commission to report on production costs for the years 1928 to 1930 to present a complete picture of the situation. Noting that the commission had thus broadened the inquiry, C. F. Kelly, president of the Anaconda Copper Mining Co., and others, requested and was given permission to file a memorandum on the subject. He said the effect upon the national economy of copper at a reasonable price is important to many industries, and that the arguments presented at the hearing were predicated more on future than present conditions.

In declaring that he is "a zealous advocate of a tariff on copper," Senator Ashurst referred to the "demoralization of the copper mining industry," saying it had seriously affected all phases of activity in Arizona. He presented a voluminous brief prepared by Hoval A. Smith, of Arizona, emphasizing the urgent necessity of adequate tariff protection on copper.

In presenting to the commission a request of himself and of Senators Ashurst and Hayden, which was approved by the commission, that it include in its report all facts as to competition of foreign copper with domestic copper producers, Representative Douglas said it was the intent of Congress that the commission should present a report showing the true condition of the industry in relation to its world and competitive phases. Mr. Douglas presented communications favoring a copper tariff from the following Representatives: Chavez (Dem., N. M.); Evans (Dem., Mont.); Colton and Loofbourow (Reps., Utah); Englebright (Rep., Calif.); and James and Michener (Reps., Mich.).

Former Representative Campbell, of Kansas, representing a group of domestic producers, said recent changed conditions in copper production in the United States and abroad have brought about a situation that will make the return of prosperity to the domestic copper industry "impossible without protection to the American producers." He appeared in behalf of the following companies: Calumet and Hecla Consolidated Copper Co., Copper Range Co., Consolidated Copper Mines Corp., Ducktown Chemical and Iron Co., Miami Copper Co., Mohawk Mining Co., North Butte Mining Co., North Carolina Exploration Co., Old Dominion Co., Phelps-Dodge Corp., Quincy Mining Co., Seneca Copper Mining Co., Shattuck-Denn Mining Co., Tennessee Copper Co.

Declaring that future conditions in the industry must be considered in relation to the economic condition of the copper industry, Clinton Bernard, representing the foregoing group of producers, showed the competitive advantages which were being obtained by foreign producers over the domestic industry. He declared that the production of copper in foreign countries has increased 10 fold more than the output of American mines. In foreign countries, copper mines were aided by subsidies and other government assistance, while in the United States the copper mines bear a great part of the expense of government. Mr. Bernard stated that the copper content of ores in foreign countries is greater than in the United States, instancing a copper content of 81 lbs. per ton in Rhodesia to 23 lbs. per ton in America. Rhodesia was said to have 472 million tons of ore, the Belgian Congo 86 million tons and Canada as being an important producer, while the United States has seven large developed ore bodies containing a billion and a half tons of ore of an average grade of 1.16 percent copper, requiring more attention than 4 percent ore.

Declaring that a tariff on copper would prevent an indefinite shut-down of a majority of even the greatest mines in this country, W. W. Lynch, mining engineer, appearing for the group of copper companies above named, said that since 1927 the United States had not been a dominant factor in the copper industry, and that the American market is being sought by the surplus of foreign copper production. "Since 1927," he said, "foreign production of copper has increased and is not only dominating conditions in world trade but is a menace to American production." In pointing out that only 16 copper mining companies are now operating in the United States, Mr. Lynch said that American copper production had recently declined 36 percent while foreign production had declined only 6 percent.

On behalf of the Calumet and Hecla Consolidated Co., and other Michigan producers, and the Phelps-Dodge Corp., A. E. Petermann, of Calumet, Mich., declared that "the foreign market for American production is gone and the foreign production is a menace to the American market." He declared that comparative cost of production and ability to produce, in the United States and abroad, are involved in a consideration of the copper situation. As to consideration of depletion and depreciation in relation to cost, Mr. Petermann said American producers did not know the basis of these calculations in foreign countries, but that the matter could be settled by the commission in conference with accountants of the companies.

Among others in attendance on the hearing were E. O. Sowerwine, of the Anaconda Copper Mining Co.; L. Vogelstein and P. D. Wilson, of the American Metal Co., Ltd.; L. S. Cates, of the Phelps-Dodge Corp.; H. C. Bellinger, of the Chile Copper Co.; and J. F. Callbreath, secretary, American Mining Congress.

More Mines Suspend Operations—Magma, U. V. X. Resume

Several additions have been made in the last month to the list of mines that have suspended operations completely to await the coming of better metal prices. Among them is Old Dominion, at Globe, Ariz., a branch of the Phelps-Dodge Corporation, which closed the latter part of September, affecting approximately 500 men. Salaried employes and a maintenance staff of 50 will remain on duty, according to I. H. Barkdoll, general manager. Moctezuma Copper Company, Nacozari, Sonora, Mexico, has also shut down.

The Quincy mine of the Quincy Mining Company, in the Michigan copper district, suspended operations September 22. The mine will be kept in condition for immediate reopening. Mohawk Mining Company has temporarily suspended exploratory work in its property in Ontonagon County.

Magma and United Verde Ex. Resume

Magma Copper Company, Superior, Ariz., resumed production on October 1, providing full time employment for about 650 men, according to William Koerner, general manager, who also announced that there would be no wage cut. Magma ceased production July 1, but all employes have been working on at least a half-time basis, engaged in development and other work.

United Verde Extension Mining Company will resume operations about November 1 at its Jerome mines and the smelter at Clemenceau, Ariz., according to George Kingdon, general manager. Mr. Kingdon stated that the resumption is being made to relieve unemployment of the company's men during the winter. It was also said there would be no reduction in the present scale of wages, and only men who were on the pay roll when the mine and smelter closed July 1 will be given work.

IRON ORE RESERVES DIMINISHING—REPORT CITES UNFAIR TAX POLICY

PRESENT known reserves of high-grade Lake Superior iron ore would be entirely exhausted in less than 30 years if the rate of shipment prevailing in recent years were to continue and no additions to the reserves be made, says the Union Trust Company, of Cleveland, in a study of ore reserves.

Michigan and Minnesota iron ranges show high-grade reserves of 1,357,538,843 tons, against which average shipments have been 50,000,000 tons annually. One factor which will vitally affect the length of the period the iron and steel industry can look to Lake Superior for its supplies of iron ore, the report states, is the existence of unknown quantities of low-grade ore.

"One situation which puts the mine operators under the necessity of going on in the working of high-grade deposits even to the point of their serious depletion before making any definite attempt to use low-grade ore is the taxing policy of the ore-producing states, particularly Minnesota.

"Iron-ore companies operating in Minnesota pay the heaviest taxes of any industry in the world, state and local taxes there on ore mining being more than 22 percent of the value of ore mined, compared with the average rate of 1.5 percent of state and local taxes on the product of all industries and trade in the United States."

It is pointed out that the ore industry is subject to sharply defined economic limitations, lake ores being unable to compete with southern ores in that territory or with local or foreign ores in seaboard territory. The use of scrap in steel melting also is increasing rapidly, it is said, because of its relatively lower cost, with a resulting reduction in ore requirements.

Smelters Start Up

Smelting operations were resumed at the East Helena, Mont., plant of the American Smelting & Refining Company the middle of September, and the company's Murray plant in the Salt Lake Valley started up again the first of October after the summer shutdown.

The International Smelting Company will reopen its lead smelter at Tooele, Utah, about the first of November, according to J. O. Elton, manager.

Copper Companies Cut Wages

Wage cuts ranging from 5 to 15 percent have been made by the major copper producers in an attempt to lower production costs following the recent drops in the price of copper to new all-time lows.

Wages in Arizona mines were reduced about 9 percent on October 1, bringing the scale to $4.50 a day for miners and $4 for muckers, the basic rate which prevailed on May 1, 1921. The companies affected are Phelps-Dodge, Calumet & Arizona, United Verde, Ray Consolidated, New Cornelia, Inspiration and Arizona Commercial.

Early in October Anaconda Copper Mining Company announced salary cuts of from 5 to 15 percent. Wage scales were adjusted downward, but the extent of the reduction was not given.

Ten percent cuts have been made by American Smelting & Refining at its smelting plants at Garfield and Murray, Utah. On October 1, Utah Copper posted notices of a reduction of 10 percent, the first wage cut since June, 1930, when a similar revision was made.

Mohawk Copper Company, in the Michigan copper district, announced reductions of from 10 to 15 percent, dating from October 10, and Copper Range made a cut in wages and salaries of 17½ percent, effective October 1. A minimum, however, has been established for married men. The mines and plants are working four days a week.

Arizona Mine Valuations Before Court

The Yavapai County, Ariz., Superior Court has decided that the valuation of the United Verde Extension Mining Company be placed at $5,710,000 for taxation purposes. This company, United Verde Copper and the Copper Queen Branch of Phelps-Dodge paid their 1931 taxes under protest.

The attorney general, filing notice of an appeal, claimed that the United Verde Extension valuation should be between $8,000,000 and $9,000,000. The state tax commission fixed the figure at $14,812,000. United Verde Copper protested a valuation of $35,000,000 and Phelps-Dodge Corporation against a valuation of $27,000,000 on its Bisbee property.

The copper companies in Arizona pay approximately 45 percent of the total taxes paid in the state.

The Department of Commerce has been advised that the production of minerals in Manitoba, Canada, this year is expected to double the 1930 output, due to the operation of new zinc properties in the northern part of the province.

Northwest Mining Association Meets December 1

The thirty-seventh annual convention of the Northwest Mining Association will be opened at Spokane, Wash., on December 1, to continue throughout the week, it has been announced by Leon Starmont, secretary. There will be a preliminary meeting of the trustees and special committees on November 30.

The second day of the meeting, December 2, will be given over to the Northwest section of the American Institute of Mining & Metallurgical Engineers. Thursday, December 3, will be occupied by the Washington Natural Resources Association, and sessions of the Western Division of the United States Chamber of Commerce will be held on December 4. The annual banquet of the Mining Association will be held the evening of December 3, and will be conducted jointly by the cooperating organizations.

War Minerals Producers File Briefs Supporting Claims

Briefs have been filed by the Vindicator Consolidated Gold Mining Co., and the Chestatee Pyrites and Chemical Corp., in the U. S. Supreme Court in support of a decision of a lower court allowing them to recover from the Government under war mineral relief legislation on account of losses in connection with the purchase of property and for interest on borrowed capital, which cases were argued before the court during the week of October 26. The companies contend that these losses are reimbursable. "From the time the Interior Department began to consider these claims, under the act of 1919, its acts have been questioned by claimants, criticized by congressional committees, reversed by some courts, and Congress enacted amendatory and supplemental acts in 1921, 1924, and 1929, for the purpose of changing the administrative action," says the briefs. "There has been continued effort on the part of Congress to aid claimants in over-turning the construction of the department. The law is simple and not difficult to understand. The only ambiguity that has arisen as to its meaning results from an extraneous circumstance not fully understood by the Secretary of Interior or Attorney General, each of whom used it as a basis for an opinion."

In pointing out that some of the arguments now advanced by the Government against the payment of these claims were not made by the Secretary of Interior in prior consideration of these cases, the briefs say that these later arguments are contrary to what the Secretary had previously ruled.

It is also pointed out by the companies that by an act of June 7, 1924, Congress removed a prior limitation of $8,500,000 for paying war mineral awards and left in force the original appropriation of $50,000,000, on a statement of the Interior Department that if interest on borrowed capital and purchase property losses were allowed the smaller appropriation would be inadequate. By this action it is contended that Congress approved decisions of the courts in allowing purchase property and interest losses.

Argument is also advanced that committees of Congress considering the act of 1929 and the representatives of the Interior Department knew and intended that the act should give the courts power to decide that as a question of law the department should pay losses for purchase of property and interest on borrowed capital, and that all discretion to disobey the law thus to be decided by the courts was taken from the Secretary of Interior.

Phelps-Dodge Has Perfect September Safety Record

All five branches of the Phelps-Dodge Corporation scored perfect safety records during the month of September with no lost-time accidents, the first time this has ever happened. On a few previous occasions as many as three of the five branches have turned in perfect records during a month's period, but the present performance sets a new record.

A total of 45 lost-time accidents have been chalked up by all five branches for the year to date. The Morenci Branch is leading with 3; the Moctezuma unit is second with 6; Copper Queen third with 15; Stag Canon Branch is fourth with 4; and the Old Dominion last with 17. The ratings are figured on the basis of 1,000 shifts worked. On this basis the ratings are as follows: Morenci, .013; Moctezuma, .024; Copper Queen, .047; Stag Canon, .059; Old Dominion, .142.

Ferry Again Heads Silver Producers

W. Mont Ferry was reelected president of the American Silver Producers' Association at the organization's annual meeting at Salt Lake City, subject to the confirmation of the board of directors. Other officers named were: Frank M. Smith, first vice president; Robert E. Tally, second vice president, and Henry M. Rives, secretary-treasurer. Mr. Ferry has been head of the association since its organization seven years ago. He will call a meeting of the board in New York soon to decide on what future action the association will take to assist in the rehabilitation of silver.

Directors elected were: Mr. Ferry, Frank M. Smith, Robert E. Tally, C. F. Kelley, Jerome E. Day, James F. McCarthy, Stanly A. Easton, James R. Hobbins, E. V. Daveler, Jesse F. McDonald, J. C. Kinnear, F. H. Brownell, F. Y. Robertson, and William R. Wade.

Hartman Gold Acquires Claims

The Hartman Gold Mining Company recently secured three sets of patents from the U. S. Registrar, completing their ground including the claims acquired from the Oatman Gold Mining Co., making 18 claims in one compact body in the heart of the Oatman district of Arizona. The mine has a complete plant and operates the largest three compartment shaft in Oatman.

A company has been organized in London to buy and sell platinum produced in Canada, Russia, South Africa, and Colombia.

Bethlehem-Youngstown Merger Abandoned

The merger of the Youngstown Sheet & Tube Company with the Bethlehem Steel Corporation was abandoned October 15, with an announcement from E. G. Grace, president of Bethlehem, that the merger contract had been cancelled. Opposition to the merger was led by Cyrus S. Eaton, of Cleveland. Against the Eaton group was President Grace, of Bethlehem, and J. A. Campbell, chairman, of Youngstown. When the merger election was held, Youngstown officials declared a majority had approved the combine, but Eaton won the long court fight when the transaction was enjoined. An appeal from the injunction was never decided.

Philadelphia & Reading Building Second Large Breaker

The Philadelphia & Reading Coal & Iron Company has started work on its $5,000,000 breaker at St. Nicholas, Pa., the second large central unit in its program. The St. Nicholas breaker will prepare coal from mines in the Mahoney City and Shenandoah districts, and will replace seven smaller breakers that are now in operation. Stone & Webster Engineering Corporation are the designers and builders.

Before work on the new breaker was started it was necessary to drill a number of boreholes and force slush from nearby breakers into old underground workings which had to be filled to prevent settling of the ground. A railroad station and 25 homes had to be demolished to clear the site, a viaduct for vehicular traffic built over the network of railroad yards, and a creek channel was diverted by a flume to make way for the structure.

W. Va. Miners Agree to Wage Cut to Meet Nonunion Competition

Representatives of District 31, United Mine Workers, and Northern West Virginia operators agreed to a 25 percent reduction in wages in order to meet competition of non-union operations at a meeting October 2 in Fairmont. The new scale provides a rate of 24 cents per ton for loaders with comparable wages for outside men and others.

The contract provides for meeting of the union and operators every two months to make any adjustments that may be necessary.

A resolution instructing union officials to negotiate contracts that will allow union mines to operate in competition with non-union operations until the non-union operators sign contracts with the United Mine Workers, was adopted at a special meeting of District 31, United Mine Workers of America, at Fairmont the latter part of September.

Further hearings on complaints of Central and Western Pennsylvania bituminous coal producers against the Baltimore & Ohio and other railroads will be held in Washington January 4, instead of October 27. The complaints concern the failure of the roads to provide joint through rates on bituminous coal.

Personals——

S. R. ELLIOTT, general manager of the mines department of The Cleveland-Cliffs Iron Company, was recently appointed to the Michigan State Board of Aeronautics.

✣

LUCIEN EATON, for a number of years superintendent in the Ishpeming, Mich., district for the Cleveland-Cliffs Iron Company, returned from London on September 13. Mr. Eaton is now affiliated with Rhodesian Selection Trust, Ltd., as consulting engineer.

✣

R. C. ALLEN, Cleveland, vice president of Oglebay, Norton & Company, was a recent visitor in the Lake Superior region.

✣

ROBERT E. TALLY, vice president of the United Verde Copper Company, was in Washington, October 19, and spoke at a banquet given by the Washington Section of the A. I. M. E.

✣

ROBERT M. ATWATER, JR., of New York City, president of the Interstate Zinc & Lead Company, has been elected president of the New York Mining Exchange.

✣

L. A. LEVENSALER, formerly northwestern representative of the mining department of American Smelting & Refining Company, who has been in Alaska inspecting placer gold properties in which he is interested, since closing of the company's office in June, recently returned and will resume offices in the Hoge Building, Seattle, as consulting engineer.

✣

GEORGE W. LAMBOURNE, president of the Park Utah Consolidated Mines Company, returned to Salt Lake City late in September after a four months vacation tour of Europe, which included visits to Great Britain, France, and Germany.

✣

E. W. KELLY has been elected president of the Lehi Tintic Mining Company. Ralph A. Badger was elected secretary.

✣

A. E. LARSON, of Yakima, Wash., formerly vice president of the Sunshine Mining Company, has been elected president of the company, succeeding the late John Sawbridge. Alex Miller was elected vice president, and C. M. Hull elected to the board.

✣

D. D. IRWIN, manager of Roan Antelope Copper Mines, Ltd., of Northern Rhodesia, is in the United States on a three months vacation. Mr. Irwin was guest at a luncheon given in Duluth, October 5, given by Edward C. Congdon. Prior to going to Africa three years ago, Mr. Irwin was general superintendent of the Copper Queen Branch of the Phelps Dodge Corporation.

✣

ALEXANDER BONNYMAN, chairman of the board of the Blue Diamond Coal Company, Knoxville, sailed for a cruise of the Mediterranean late in October, and will join Mrs. Bonnyman in Paris.

DR. F. G. COTTRELL, of the Fixed Nitrogen Research Laboratories, Washington, D. C., visited at the Utah Engineering Experiment Station October 1 and 2. Dr. and Mrs. Cottrell have been living in California for the past few months, where Dr. Cottrell was doing some special work.

✣

GEORGE J. ANDERSON, president of the Consolidation Coal Company, has returned to his offices in New York after a prolonged absence due to illness.

✣

DR. D. A. LYON, director of the Utah Engineering Experiment Station, has returned from Joplin, where he attended the joint convention of the American Mining Congress and the A. I. M. E. Dr. Lyon is a member of the institute's committee on engineering education, which held a special meeting at the convention. He was appointed a member of a subcommittee, the purpose of which is to expand and make permanent the work of the general committee on engineering education.

✣

A. B. PARSONS has just been elected secretary of the American Institute of Mining and Metallurgical Engineers. He succeeds H. Foster Bain, who resigned to make a study of research for the Copper and Brass Research Association. Mr. Parsons was elected assistant secretary of the Institute in 1929 and has been acting secretary since the first of the year.

✣

GENERAL BRICE P. DISQUE, executive director of the Anthracite Institute, attended the recent meeting of the New York State Coal Merchants' Association at Saranac, N. Y., and outlined to the delegates the work and purposes of the institute. His talk covered the operations of the following departments: Research, publicity, statistical and information, economics, and distribution.

✣

WALTER H. CUNNINGHAM has been appointed executive vice president of Binkley Coal Company, Chicago, Ill. Mr. Cunningham organized the Truax-Traer Coal Company in 1928 and served as its president until June of this year, when he was made chairman of the executive committee and chairman of the board of the Cabin Creek Consolidated Coal Company. He is also a vice president of the National Coal Association.

✣

FRED H. PFAHLER, Chicago, formerly vice president of the Superior Coal Company, has been elected president of the company, succeeding William H. Dalton.

DR. HENRY MACE PAYNE, consulting engineer for the American Mining Congress, spoke at the University of Utah October 9. His subject was "The Responsibility of the Engineer, the Economist, and the Business Man in State Development and National Affairs."

✣

CLIFFORD D. CALDWELL has been elected a director of United Electric Coal Company, to succeed John H. Sherburn.

✣

WALTER BARNUM, New York, president of the Pacific Coast Company, is in Europe for a short stay.

✣

FRANK G. FREY, for several years assistant director of the Anthracite Service, has been appointed director, according to an announcement of the Anthracite Institute. Frey is a graduate of the School of Mechanical Engineering of Lehigh University and regarded as one of the leading authorities on hard-coal combustion. The Anthracite Service, which Mr. Frey now heads, has offices in most of the principal cities east of Chicago and north of Richmond.

Obituary

SAMUEL MATHER, pioneer in the iron, steel and coal industries and the Great Lakes shipping fleets, whose name is associated with those of Andrew Carnegie, Marcus A. Hanna, and Henry C. Frick, as the men "who wrought at the mainsprings of the Nation's industries," died October 18 at his home in Cleveland, at the age of 80.

Mr. Mather's career started in the offices of his father, head of the Cleveland Iron Mining Company. In 1883 he became associated with Col. James Pickands, and with him organized the firm of Pickands, Mather & Company. From then on his record was one of steady progress during the course of which he became an executive officer in many of the companies which have shaped the course of the iron, steel, coal and coke industries of the United States. He was a dominant factor in bringing about the merger of the companies which now comprise the Youngstown Sheet & Tube Company. Among the other corporations with which he has been identified are the U. S. Steel Corporation, The Cleveland-Cliffs Iron Company, the Provident Coal Company, the Bankers Trust Company, Toledo Furnace Company, Union Trust Company, Interlake Steamship Company, and Lackawanna Steamship Company.

Funeral services were held October 21 in the Trinity Episcopal Cathedral, Cleveland.

JOHN SAWBRIDGE, of Yakima, Wash., president of the Sunshine Mining Company, died September 10 at the age of 74. Mr. Sawbridge was well past 50 before engaging in mining. Some 12 years ago became interested in the Sunshine Mine in the Coeur d'Alenes and was regarded as the principal factor in its successful development from the status of an abandoned past producer into a rich silver mine. Mr. Sawbridge was active in affairs of the Northwest Mining Association.

ALBERT JEFFERSON SAYERS, noted Link-Belt engineer, 61 years old, passed away at his home, 7121 Eggleston Avenue, Chicago, on October 11. Mr. Sayers was head of the coal tipple and coal washery department of Link-Belt Company, Chicago. He was well known throughout the entire coal industry, having designed and built numerous plants for the handling and preparation of coal, in all parts of the country.

In the 32 years of his affiliation with Link-Belt Company, Mr. Sayers become a leading factor in the mechanical handling, screening and washing of coal. He was a member of the A. S. M. E., the Manufacturers Division of the American Mining Congress, and other engineering organizations, where his contributions to the advancement of engineering principles adaptable to the industry were recognized factors of importance.

THEO. H. M. CRAMPTON, consulting and mining engineer, died suddenly in Santa Monica, Calif., September 30, at the age of 41. Shortly after graduation from the Colorado School of Mines in 1914, Mr. Crampton, with his brother, Frank A. Crampton, formed the firm of Crampton and Crampton, and conducted a general mining and consulting engineering practice which, until 1923, was interrupted only during the World War.

Over a period of several years, Mr. Crampton was active in Arizona and Nevada, and was on the staff of Thomas Campbell before and after his terms as governor of Arizona. For five years past he had been the supervising engineer of the Concrete Products Section for the Johns Manville Corporation, which firm he had left in June of this year to conduct a private engineering practice and resume research work with his brother.

A. I. M. E. Coal Division Meets at Bluefield

Meeting at Bluefield, W. Va., October 9 members of the Coal Division of the American Institute of Mining and Metallurgical Engineers were treated to an excellent program of papers dealing with coal operating and economic problems, and on the following day were taken on a tour through the Pocahontas Field through the courtesy of the Pocahontas Operators Association. The business sessions were presided over by John J. Lincoln, vice president, Crozer Coal & Coke Company, and Howard N. Eavenson, president, Clover Splint Coal Company.

On the evening of the 9th there was a banquet attended by 225 persons. W. D. Tyler, vice president of the Clinchfield Coal Corporation, presided, and speakers were E. L. Greever, Congressman H. I. Shott, H. Foster Bain, Dr. R. V. Wheeler, Howard N. Eavenson, and C. B. Huntress.

Alabama Mining Institute Meets

The annual meeting of the Alabama Mining Instiute was held in Birmingham October 12. Three new members of the board of directors were elected as follows: Clarence L. Moss, president, Moss and McCormack; Horace Hammond, vice president, Alabama By-Products Corporation; and G. F. Peter, president, Southern Coal & Coke Company. Other members of the board are: Harold McDermott, vice president, Newcastle Coal Company; R. T. Daniel, president, Franklin Coal Mining Company; L. E. Geohegan, vice president, Gulf States Steel Co.; Milton H. Fies, vice president, DeBardeleben Coal Corp.; D. E. Wilson, vice president, Woodward Iron Co.; and Howard M. Brooks, vice president, Alabama Fuel & Iron Co.

Officers will be selected at a later meeting of the board.

A resolution was adopted at the meeting commending the chief coal mine inspector of the state and his assistants for their efforts toward mine safety.

COAL PRODUCERS ORGANIZE FOR STABILIZATION OF INDUSTRY

SEVENTY executives of bituminous coal mining companies, representative of the producing area east of the Mississippi River, met in New York on October 21 to consider ways and means of stabilizing coal production, and after a full day's discussion a committee of 14 operators was appointed to study the numerous proposals that have been submitted and to make a report at another meeting to be held in the near future. The meeting was called by C. E. Bockus, president of the National Coal Association.

The meeting was presided over by J. G. Bradley, president of the Elk River Coal & Lumber Company and also head of the West Virginia Coal Association. Mr. Bradley acted in place of C. C. Dickinson, of the Dickinson Fuel Company, who was unable to attend due to illness in his family.

Mr. Bockus, at the outset of the meeting, offered the cooperation of his organization. He stated that the coal industry "needs careful piloting and wholehearted cooperation from all those directly or indirectly connected or concerned with it."

Eleven of the fourteen members of the special committee held an all-day session Thursday, the 22nd, and adjourned Friday afternoon to meet in New York on November 4 to hear the report of a subcommittee named to develop several suggestions. After the special committee has acted on the report of the subcommittee there will be another general meeting.

The special committee of 14 is composed of the following:

E. C. Mahan (chairman), president, Southern Coal & Coke Co., Knoxville; George J. Anderson, president, Consolidation Coal Co., New York; W. J. Cunningham, president, Crummies Creek Coal Co., Crummies, Ky.; C. C. Dickinson, president, Dickinson Fuel Co., Charleston; J. D. Francis, vice president, Island Creek Coal Co., Huntington; Michael Gallagher, president, Northwestern Mining & Exchange Co., Cleveland; George B. Harrington, president, Chicago, Wilmington & Franklin Coal Co., Chicago; R. H. Knode, president, Stonega Coke & Coal Co., Philadelphia; J. D. A. Morrow, president, Pittsburgh Coal Co., Pittsburgh; W. D. Ord, president, Empire Coal & Coke Co., Landgraff, W. Va.; C. F. Richardson, president, West Kentucky Coal Co., Sturgis, Ky.; W. L. Robison, vice president, Youghiogheny & Ohio Coal Co., Cleveland; J. W. Searles, president, Pennsylvania Coal & Coke Corp., New York; R. H. Sherwood, president, Central Indiana Coal Co., Indianapolis.

SEPTEMBER COAL PRODUCTION

The total production of bituminous coal for the country as a whole during September, with approximately 25.3 working days, amounted to 31,919,000 net tons as against 30,534,000 tons produced during the 26 working days in August, according to the Bureau of Mines. The average daily rate of output in September amounted to 1,262,000 tons, an increase of 88,000 tons, or 7.5 percent, over the rate of 1,174,000 tons for August.

Anthracite production in the State of Pennsylvania amounted to 4,358,000 net tons, in comparison with 4,314,000 tons in August. The average daily rate of output, based upon 25 working days in September and 26 in August, increased by 8,400 tons, or 5.1 percent, in September.

Governors Working for Coal Relief

Governor Flem D. Sampson, of Kentucky, appointed a committee of operators early in October who met in Lexington on the 15th and adopted a "plan" for the curtailment of coal output, the nature of which was not divulged. A subcommittee, however, was instructed to lay the proposal before committees from other states. The governor subsequently announced that he would invite state committees of operators to meet in Lexington early in November. In view of the concerted action which has been taken since then, it is a matter of conjecture whether the meeting will materialize.

On October 18 a committee of five bituminous coal operators was invited by Governor Pinchot, of Pennsylvania, for the purpose of conferring with Secretary of Mines Walter H. Glasgow and himself on means of relieving the unemployment situation in the soft coal field. Members of the committee are: John M. Jamison, president, Jamison Coal & Coke Co.; J. T. M. Stoneroad, president, Carnegie Coal Co.; C. F. Hosford, Jr., president, Butler Cons. Coal Co.; R. Templeton Smith, of Pittsburgh; and Walter A. Jones, of the Central Pa. Coal Producers' Assn. The time for the conference was not definitely set.

Governor George White, of Ohio, has announced plans for conferences of coal miners and operators with a view to obtaining an agreement on wages and working conditions, the miners' representatives to meet with him on October 29 and the operators on the following day.

COAL AND ORES FACE RATE INCREASES IN I. C. C.'S PROPOSAL

ALL mineral products face freight rate increases of $3 per car, and in some cases $6, in the substitute plan offered the railroads by the Interstate Commerce Commission following its denial of a general 15 percent increase.

On commodities included under the following descriptions there would be an increase of $3 per car:

Anthracite coal, bituminous coal, coke, iron ore, copper ore and concentrates; lead ore and concentrates, zinc ore and concentrates, ores and concentrates not otherwise specified, gravel and sand (other than glass or molding), stone, broken, ground or crushed, products of mines not otherwise specified, posts, poles and piling, pulp wood, lumber, shingles and lath, box, crate and cooperage materials, veneer and built-up wood, products of forests, except excelsior (wood), and sawdust, furnace slag.

On commodities included under the following descriptions there would be an increase of $6 per car:

Phosphate rock, crude (ground or not ground), sulphur (brimstone, iron, pig, scrap iron and scrap steel, stone, petroleum, crude, asphalt (natural, by-product, or petroleum), artificial stone, not otherwise specified.

On a number of other commodities, including all less-than-carload freight, there would be increases of 1 or 2 cents per 100 pounds. Rates on agricultural products, with a few exceptions, will not be disturbed.

Railroad executives, meeting in Atlantic City, October 22, agreed to accept the commission's proposal provided it was changed so that the additional revenue gained be loaned instead of given to the weaker roads. An advisory committee was instructed to go to Washington as soon as possible and take up with the commission the proposed change and report back to the Association of Railway Executives for its approval.

Comprehensive Program Completed for International Coal Conference

Almost 100 papers, contributed by scientists of 15 nations, are listed in the program of the Third International Conference on Bituminous coal which will be held November 16 to 21 in Pittsburgh, according to Dr. Thomas S. Baker, organizer of the meeting and president of the Carnegie Institute of Technology, under whose auspices the world gathering of fuel technologists is being held. Every phase of coal utilization will be treated. The speakers include scientists who are recognized as authorities in the several fields of coal research.

As a result of the papers and discussions which will be given, the coal man will be furnished with an accurate picture of the coal industry throughout the world. The mine owner should be able to predict as a result of the meeting what the demands for his product will be in the future by the major consumers.

A section on the economics of the coal industry has been included in the conference this year for the first time. Among the speakers in this section will be Governor Albert C. Ritchie, of Maryland, and Myron C. Taylor, chairman of the Finance Committee of the United States Steel Corporation. The interrelationships that exist between coal, petroleum and natural gas will be discussed by Dr. W. T. Thom, Jr., of Princeton University. This address will contain an authoritative resume of the economic situation in the three major fuel industries, and will propose a method for the rehabilitation of the soft coal industry. Other speakers in this group will be C. E. Bockus, president of the National Coal Association, and Alfred C. White, of the National Industrial Conference Board.

Pulverized coal will come in for major discussion. Three sectional meetings, in which 11 papers will be presented, will be held. Among the speakers in this group will be Richard Roosen, of Germany, who will present the outcome of experiments with the use of pulverized coal in locomotives.

Other sections of the conference will be concerned with gasification, hydrogenation and liquefaction, low and high temperature distillation, coal cleaning and preparation, smoke and dust, by-products, origin and classification, domestic heating, metallurgy, and competition of coal with other fuels.

Among the distinguished foreign scientists who will be present are Dr. Franz Fischer, director of the Kaiser Wilhelm Institute for Coal Research, Mulheim-Ruhr; Prof. R. V. Wheeler, of the University of Sheffield, England; Dr. Friedrich Bergius, of Heidelberg; Prof. Cecil H. Desch, University of Sheffield, England; C. M. Stein, industrialist, Paris, France; Prof. Dr. Ernst Berl, of Darmstadt; and Andre Kling, director of the Municipal Laboratory of Chemistry, Paris, France.

Coal Mine Fatalities Again Decrease

Accidents in coal mines in the United States during September caused the death of 107 men, according to the United States Bureau of Mines. This was a reduction of seven from the figure for August, and a reduction of 33 from the 140 deaths which occurred in September a year ago. While production of coal in September declined 17 percent as compared with the same month last year (from 43,893,000 tons to 36,277,000 tons), the number of fatalities was reduced 24 percent (from 140 to 107). A comparison of September with August of the current year shows an increase of 4 percent in tons produced but a decrease of 6 percent in fatalities, with the August record covering 34,848,000 tons of coal produced and 114 men killed by accidents. Death rates per million tons were 2.95 for September and 3.27 for August of the present year and 3.19 for September a year ago.

The rate of 2.95 for September, 1931, stands at present as the lowest rate on record except on two occasions, namely, December, 1930 (rate 2.75), and December, 1922 (rate 2.92).

Considering bituminous mines alone, a lower death rate was shown in September, 1931, than in either the corresponding month of 1930, or in August of the present year, the rate being 2.32 as compared with 2.67 in September a year ago, and 2.82 in August, 1931. Seventy-four men were killed in bituminous mines in September of this year, 86 in August, and 103 in September, 1930.

In the anthracite mines of Pennsylvania 33 men lost their lives during September, and in August 28 men were killed as compared with 37 in September, 1930. The fatality rates per million tons of coal produced for these three months were 7.57, 6.49, and 7.03, respectively.

During the 9-month period from January to September of the current year, 1,079 lives were lost in the mining of 326,208,000 tons of coal, resulting in a death rate of 3.31. Reports for the same period in 1930 showed 1,462 deaths and a production of 390,270,000 tons of coal, with a resulting rate of 3.75. The death rate for bituminous mines alone, which had a record of 783 deaths, was 2.78 for the period from January to September, as compared with 3.32 for the same period in 1930, when 1,128 deaths occurred. The anthracite record for the 1931 period was 296 deaths and a fatality rate of 6.70, as compared with 334 deaths and a rate of 6.60 for the 9-month period in 1930.

The bituminous coal mining industry has established what is almost an all-time record for freedom from major disasters, in that it has gone eight months (February to September, inclusive) without a major explosion or a major disaster of any kind.

European Coal Producers Confer on Cartel

Representatives of the chief European coal producing countries met in London September 30 to work out a method of cooperation, with a view of eliminating some of the competition between the coal-producing countries. The meeting was called by the British Mining Association, and Evan Williams, president, presided. Great Britain, France, Germany, Belgium, Poland, Holland and Czechoslovakia were represented.

The aim of the sponsors of the conference is an eventual coal cartel, press dispatches state, but it is admitted that the present conference is of a preliminary nature to explore the field and see what concerted action might be possible to enable the coal producers of all European countries to operate on a sound economic basis. The proceedings were said to have revealed a "satisfactory consensus of opinion of fundamental principles."

Illinois Miners' Union Amends Constitution

The Illinois district convention of the United Mine Workers of America, meeting in Springfield the middle of October, voted to amend its constitution to provide complete automony with only limited supervision by the international union. The action resulted from the recent controversy between the Illinois miners and President John L. Lewis, who was enjoined by the courts from interfering in the Illinois district affairs.

WITH THE MANUFACTURERS

New Aerovane Fan

Jeffrey Manufacturing Company, Columbus, has developed a new type of mine fan known as the "Aerovane," and having approximately twice the efficiency of the present disc or propeller fan when operating over a wide range of duties. Its blades are patterned after the airplane propeller, and its makers state that it will replace any disc or propeller type of fan at a saving of power. It will also replace many centrifugal fans where large volumes with high pressures are not required.

It is claimed that the Aerovane is the only disc or propeller fan that will maintain an efficiency of 65 percent and above when working between 40 and 80 percent of its maximum volume.

Carbon Monoxide Indicators on Airship "Akron"

Two M-S-A continuous carbon monoxide indicators have been installed on the Navy's new airship, *Akron*. The indicators were developed by Dr. J. J. White, lieutenant commander, Bureau of Medicine and Surgery, U. S. Navy; C. E. Earle, Bureau of Aeronautics, U. S. Navy; and the Mine Safety Appliances Company, Pittsburgh.

The airship is heated by means of a system of coils and pipes which circulate over the exhaust manifolds of the engines. The sampling lines of the indicators are connected to the heating duct, and percentages of carbon monoxide as low as .01 are detectable. Should a leak occur, the instruments are so designed to flash a red light in the engine compartment and sound a buzzer in the control car.

The catalyist employed in the cell construction of the instruments, Hopcalite, is the same used in the cannister of the Burrell All-Service gas mask, which is so widely employed in the mining industry for fighting mine fires and for recovery operations following mine explosions.

Link-Belt Announces New Shovel-Crane-Dragline

Link-Belt Company have anounced the addition of a new shovel-crane-dragline, known as the K-48, to their line which ranges from ¾ to 2½ cu. yds. capacity. It is an all-purpose unit, serving as a shovel, a crane, a trench hoe or a dragline, and can be furnished with any or all of the attachments which are usually only available on smaller machines. The K-48 is arranged for gasoline engine, Diesel engine, or electric motor drive. The gasoline engine has a heavy-duty 130-hp. rating, and the Diesel engine or electric motor is of corresponding capacity.

As a shovel, it is standardly equipped with a 25-ft. shovel boom, 17-ft. 6-in. dipper stick, and a 1¾-cu.-yd. dipper; as a crane it has 33 1/3 percent or more margin against tipping. It has a rated capacity of 32 tons at 12 ft. 0 in. radius and 10,400 pounds at 45 ft. radius on a 45-ft. boom, and corresponding capacities at other radii and for other boom lengths.

As a dragline, it will handle 1¾ cu. yds. heavy or 2 cu. yds. light-medium bucket on a 45-ft. boom, and a 1½ cu. yds. heavy or 1¾ cu. yds. light-medium bucket on a 50-ft. boom, with the boom at any angle convenient for dragline work. It is necessary to work with a "high" boom or at limited radius to handle these loads, as these are conservative ratings which the machine will easily and safely handle.

As a trench hoe, the character of the work and the digging depth determine the size of the bucket used. For normal digging depth, in average soils, a 2-cu.-yd. solid-bottom bucket is standard.

Standardized Markings on All Oxweld Welding Rods

The Linde Air Products Company, New York, has announced a new standardized set of markings on all Oxweld welding rods. With three exceptions, all rods ⅛ in. in diameter and larger are stamped with the name "Oxweld" as well as the number and type of rod. On the smaller sizes of welding rod where it is not possible to stamp the name, the boxes in which the rod is shipped are plainly marked "Oxweld," with the number and type.

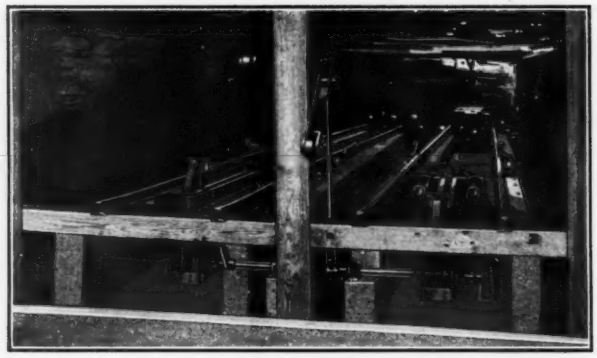
General Electric Employment

Affirming its confidence in the future of the electrical industry, the General Electric Company, through President Gerard Swope, has offered its shop employes a plan which would virtually guarantee them six months employment, beginning November 1. The new proposal, which is called "a plan to prevent further lay offs for lack of work," is to be voted on by employes of the company who are members of the General Electric unemployment pension plan, which embraces the great majority of all shop employes of the company.

Approximately $1,000,000 has already been distributed to General Electric unemployed during the 10 months since December 1, 1930, when the emergency payments under the unemployment plan were started. One-half of this was contributed by the employes working half time or more and the other half by the General Electric Company.

A booklet entitled "The Storage Battery Switching Locomotive," has been published by the Electric Storage Battery Co., of Philadelphia, which describes various units equipped with Exide Ironclad batteries. One of the types described is the 70-ton straight battery swiching locomotive shown at the left at a coal stripping operation. The locomotive is equipped with a motor-generator set, and the batteries are charged while cars are being spotted.

Bumper Stop Cagers



Car cagers for shaft bottoms or intermediate levels, employing a bumper stop and automatic release, and known as Nolan Bumper Stop Cagers, have been designed by the Mining Safety Device Company, Bowerston, Ohio. Horns, positioned a few inches ahead of the front wheels of the second car, are used only for holding the balance of the trip while the first car, released by the bumper stop automatically as the cage reaches the bottom, passes onto the cage. There is little or no movement against the horns, and therefore no strain on car wheels or axles.

The two caging machines are connected so that when the right-hand cage reaches the bottom the bumper stop member of that cager is lowered to release the car. This cager remains in this position until the left-hand cage has come to the bottom, lowering the bumper of the left-hand cager and raising the bumper of the right-hand cager to allow the trip on that track to advance from the holding horns to the bumper. This method of operation allows redumping of either cage without feeding a second car at the bottom, and eliminates the necessity and danger of spragging the trip when a redump is necessary.

The bumper stop assembly is mounted with large cushion springs that absorb the shock of the trip, preventing damage to cars and reducing spillage.

Chemical Corporation Consolidates With Hercules Powder

Negotiations have been completed for the consolidation of Paper Makers Chemical Corporation with Hercules Powder Company, it is announced by Russell H. Dunham, president of the Hercules Powder Company. Hercules Powder Company is a large producer of explosives, naval stores, cellulose products, and chemical cotton. An international marketing organization, extensive research facilities, and an increased line of paper-making chemicals and materials are made available to Paper Makers Chemical Corporation through the consolidation.

George W. Moore Company Joins Link-Belt

The merger of the George W. Moore Company, of Chicago, with H. W. Caldwell & Sons Company, a subsidiary of Link-Belt Company, is announced by Alfred Kauffmann, president, Link-Belt Company. The combined units are to be known as the Caldwell-Moore Division, Link-Belt Company. Max H. Hurd, formerly president of the George W. Moore Company, becomes a vice president of Link-Belt Company, in charge of the Caldwell-Moore operations.

The facilities of two well-known manufacturers of similar lines of conveying equipment are thus consolidated, and Link-Belt acquires an entirely new line of manufacture, Salem elevator buckets.

Leon J. Cone has been appointed district manager at Duluth for the Sullivan Machinery Company. Mr. Cone succeeds Jonathan A. Noyes, for many years manager at Duluth, who has been promoted to manager of the company's coal machinery sales division with headquarters in the general offices at Chicago.

New Cleaning Plant Construction

The following new contracts have been closed recently by Roberts and Schaefer Company, of Chicago:

Barnes Coal Company, Barnesboro, Pa.: Complete steel, two-track, Marcus tipple with car feeders, cages, revolving dumps, Marcus picking table screen and rock-disposal machinery. Capacity, 500 tons per hour. Completion, November 15, 1931.

Yukon Pocahontas Coal Company, Yukon, W. Va.: Complete Hydro Separator coal-washing plant for sizing and washing 3-in. x 0 slack coal and preparing slack, pea, nut, and stove sizes. Capacity, 300 tons per hour. Completion, November 1, 1931.

Davis Coal & Coke Company, Thomas, W. Va.: Two-track Marcus picking table screen tipple of steel construction, complete with rock-disposal machinery, loading booms, fine-coal preparation and local trade; to load lump, nut, pea, and slack sizes. Capacity, 150 tons per hour. Completion, December 15, 1931.

F. J. Griffiths Joins Timken

F. J. Griffiths has joined the Timken organization at Canton, Ohio. He has been elected director and president of the Timken Steel and Tube Co. M. T. Lothrop, president of the Timken Roller Bearing Co., has been made chairman of the board of the Timken Steel and Tube Co.

Mr. Griffiths until recently was associated with the Republic Steel Corp. as president of the Republic Research Corp. He began his career in the steel industry 30 years ago with the United Steel Company, at Canton, and later helped to organize the Central Steel Company, in Massillon, Ohio, of which he was president and general manager.

Westinghouse Reorganizes Industrial Sales Department

The industrial sales department of the Westinghouse Electric and Manufacturing Company has been reorganized under the direction of O. F. Stroman, industrial sales manager, the department now being composed of units grouped according to the main classifications of industry.

Bernard Lester

Bernard Lester and C. B. Stainback have been appointed assistant sales managers, and 14 divisional managers have been appointed. Mr. Lester, long an active participant in the application of electricity to industry, will have general charge of directing from headquarters the development of business with industrial users of electrical equipment. Mr. Stainback will have charge of nine divisions specializing in apparatus applying to these industrial groupings.

C. H. Stainback

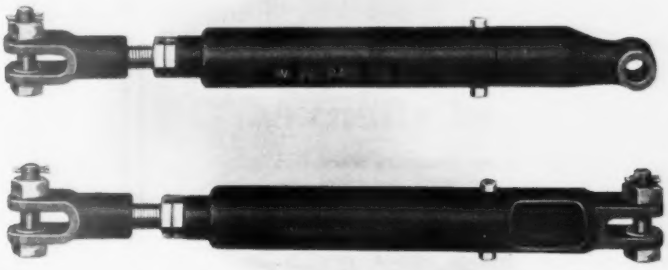
Under Mr. Lester there has been created five industry divisional classifications, including the mining and metalworking electrification division, with G. E. Stoltz as manager.

Chicago Pneumatic Tool Company has moved their office and service station at Seattle, Wash., from 1743 First Avenue South to larger quarters at 3201 First Avenue South, and appointed C. Kirk Hillman as district manager.

The Union Chain & Manufacturing Co., Sandusky, Ohio, has recently appointed C. H. Upson, 1012 Traction Building, Cincinnati, Ohio, representative in that territory.

SPRING CONNECTING RODS

This piece of modern track equipment is a direct-acting concentric spring connecting rod. Made of steel and malleable iron, all working parts are fully enclosed. Thrusts are transmitted in a straight line. The structure is strong, operating parts are protected from foreign substances and working parts can be easily removed for inspection without disturbing adjustments. Write for further details or let us send you our catalog that is full of helpful track work suggestions.



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Rails and Accessories, Frogs, Switches, Steel Ties and Special Track Work in stock for prompt shipment.

an ideal
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Solid cast aluminum wheel built in the same proportion as the propeller on heavy duty bombing planes.

Tripod base fastened with wing, nut and easily adjustable to any desired angle.

Latest ball bearing motors used for fan. Can be furnished without motor.

Safety guard will pass the most rigid safety inspection.

Traction wheels are 14' diameter allowing easy movement over rough floors.

Steel handle aids portability and guards the motor.

Hand starter switch with overload protection is fully enclosed.

With its aluminum wheel built like a bombing plane propeller this light weight fan is ideal in copper, coal and other mines where a portable fan is needed. Blows air in penetrating cork-screw spirals. Compact and efficient, easily moved from room to room. No truck for rails required. The light weight one-piece fan wheel, mounted on the end of the motor shaft eliminates motor bearings troubles. The picture will suggest new uses to you. Let us send complete description.

ROBINSON
VENTILATING Co.
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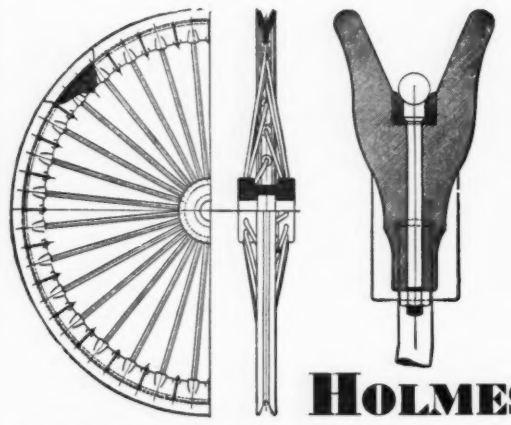

HOLMES

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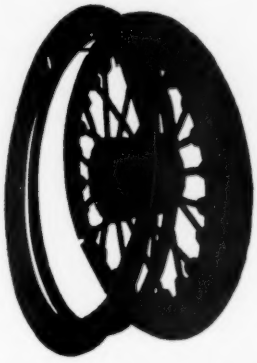

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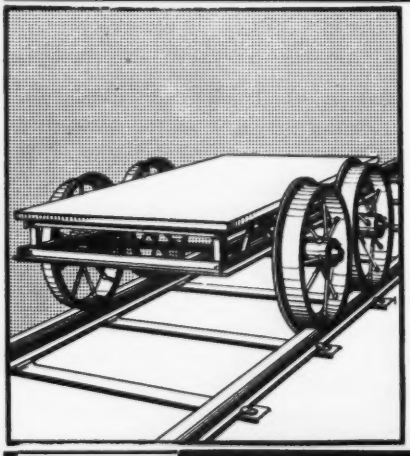

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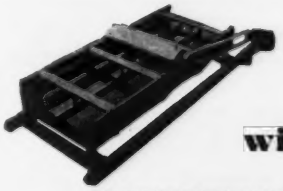

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INDEX TO ADVERTISERS

Allis-Chalmers Mfg. Co. . . . 6
American Steel & Wire Co. . . . 19
American Brass Co. . . . 11
Atlas Powder Co., The . . . 10
Ayer & Lord Tie Co. . . . 19
Connellsville Mfg. & Mine Supply Co. . . . 18
Du Pont De Nemours & Co., E. I. . . . 9
Egyptian Iron Works . . . 18
Ensign-Bickford Co., The . . . Inside Front Cover
Enterprise Wheel & Car Corp. . . . 20
General Electric Co. . . . Back Cover
Goodman Mfg. Co. . . . 14
Hercules Powder Co. . . . 13
Hoffman Bros. . . . 18
Holmes & Bros., Inc., Robt. . . . 18
Jeffrey Mfg. Co. . . . 7
Joy Mfg. Co. . . . 8
Mine Safety Appliances Co . . . 15
Mott Core Drilling Co. . . . 18
Ohio Brass Co. . . . 3
Pennsylvania Drilling Co. . . . 18
Phelps Dodge Corp. . . . 19
Robinson Ventilating Co. . . . 17
Roebling's Sons Co., John A. . . . 5
Scholz, Carl . . . 20
Stonehouse Signs . . . 20
Timken Roller Bearing Co. . . . 16
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West Virginia Rail Co. . . . 17

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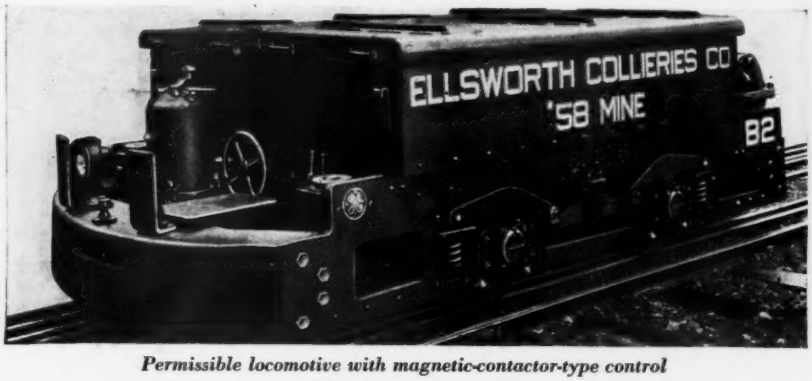
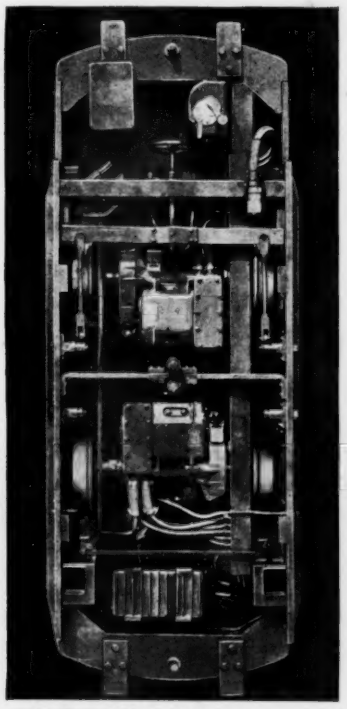


Permissible locomotive with magnetic-contactor-type control



A bird's-eye view of drum-type-control locomotive with battery box removed

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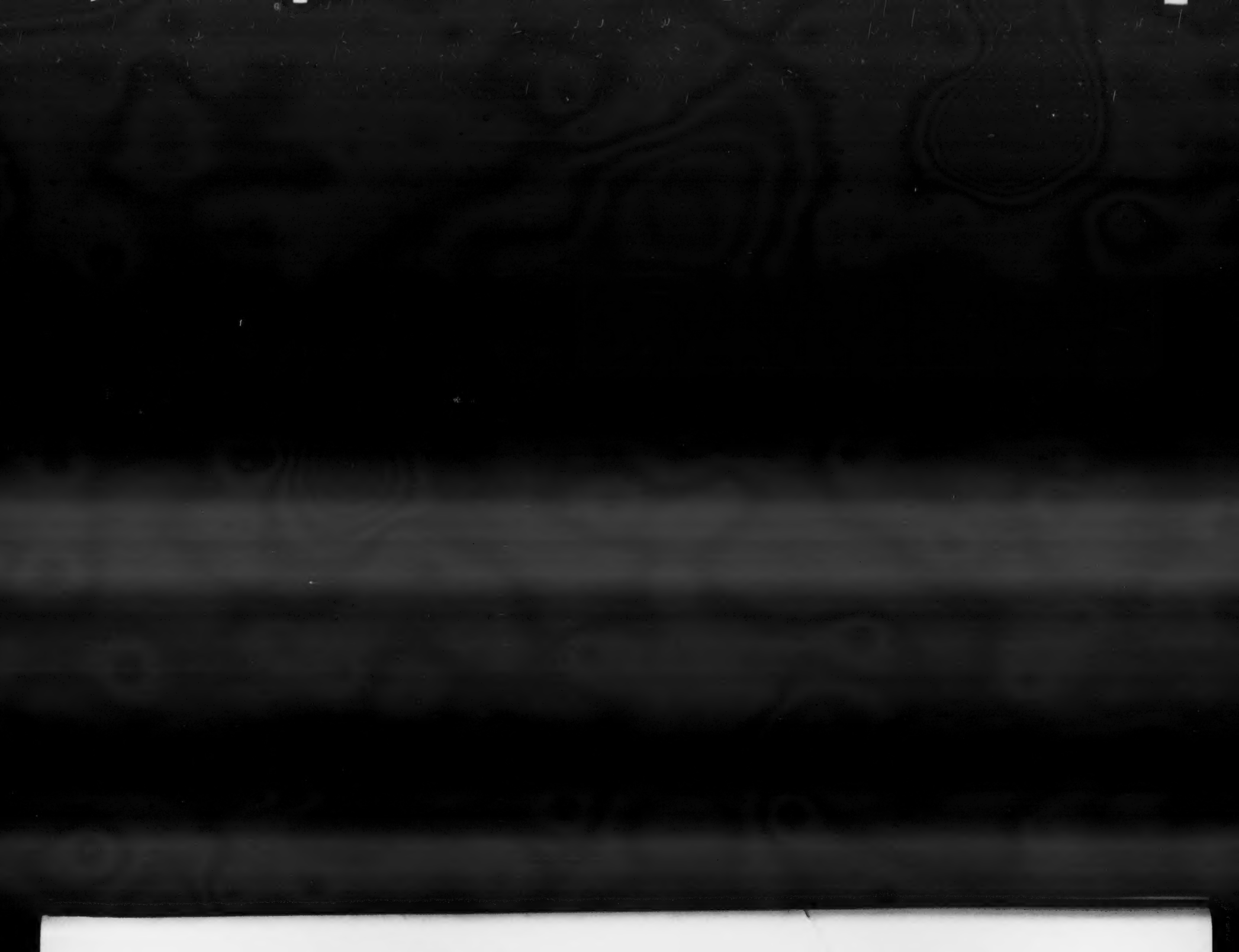
360-68